THE

JOURNAL

OF THE

CINCINNATI

SOCIETY OF NATURAL HISTORY.

PUBLISHING COMMITTEE:

A. G. WETHERBY, J. W. HALL, Jr.,
CHAS. DURY, L. M. HOSEA,
GEO. W. HARPER.

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CINCINNATI SOCIETY OF NATURAL HISTORY.

VOL. II. CINCINNATI, APRIL, 1879. No. 1.

PROCEEDINGS OF THE SOCIETY.

The Society met January 7, 1879. The President being absent, Vice-President L. S. Cotton took the chair. The minutes of the December meeting were read and approved.

Mr. Fred. Braun read a paper describing, and also exhibited, a remarkable idol, made of sandstone, and found in Tennessee several years ago. The work is quite unlike anything previously found in this country, but resembles somewhat certain Egyptian idols.

A communication was received and read from Mr. David H. Shaffer, offering his collections to the Society, on certain conditions, and requesting that a committee be appointed to confer with him upon the subject.

A motion was adopted authorizing the chair to appoint said committee, whereupon the following were announced as such: Messrs. R. B. Moore, Charles Dury and E. O. Ulrich.

Mr. R. B. Moore, on behalf of the Conference Committee on Exposition Buildings, made a final report.

On motion of Dr. R. M. Byrnes the report was received and adopted and the committee discharged, with the thanks of the Society for the

able, careful and patient manner in which it has discharged the important duty assigned to it.

The donation of a mink, by Dr. H. H. Hill, was announced.

The Society met February 4th, the President in the chair. The minutes of the previous meeting were read and approved.

Dr. G. A. Sprecher, proposed at the previous meeting for membership, was unanimously elected.

Miss Hallie G. Cotton tendered her resignation as a member of the Society.

Mr. Fred. Braun read a paper concerning and descriptive of a new crustacean fossil, the *Enoploura longicauda*, which he found in the south eastern part of Indiana. On motion the paper was referred to the Publishing Committee.

Dr. Warder gave, in a verbal communication, some very interesting information about the two varieties or species of Catalpa trees found in America, including some statements about its great durability as material for posts, railroad ties, etc.

The following donations were announced: one Cauculus anthriscus (mounted), G. C. Lloyd; two eggs of Florida Cormorant, Chas. Dury; twenty-five copies Report of Ohio Fish Commission, Cuvier Club, through Col. L. A. Harris; a copy of the Palæontologist, No. 3, U. P. James.

The Society met March 4, 1879,—Vice-President Cotton presiding. There were verbal communications by S. A. Miller, E. O. Ulrich, and others.

S. A. Miller stated in substance that the masticatory apparatus of *Ceratiocaris* and *Dithyrocaris* found in the carboniferous rocks bears a striking resemblance to the same organs in the recent lobster, and that our fossil known as *Nereidarus varians* has a striking similarity with the masticatory organs of the *Ceratiocaris* and *Dithyrocaris*, so much so that in his opinion the *Nereidarus varians* should rather be referred to the masticatory organs of our fossil crustaceans than to the annelids.

Mr. Ulrich did not agree with Mr. Miller's conclusions.

The following donations were received: Mr. Charles Dury announced by letter that he had been requested by Dr. Aug. J. Woodward to present to the Society his entire collection of Coleopterous insects, with the cabinet containing them; 1 copy each of Reports D, E, F, G, H, & O, of the 2d Geological Survey of Pennsylvania, from the commissioners, by their secretary, Wm. A. Ingham.

REMARKS ON THE GENUS PTEROTOCRINUS, LYON and CASSEDAY.

BY A. G. WETHERBY, A.M.,

Professor of Geology and Zoology, University of Cincinnati.

Asterocrinus Lyon ; *Geological Survey of Kentucky*, old series, vol. iii., p. 472, pl. iii., figs. 1*a* to 1*k*.

Dichocrinus Shumard ; *Transactions St. Louis Academy of Science*, February 9, 1857.

Pterotocrinus, Lyon and Casseday ; *American Journal of Science and Arts*, Vol. xxix., p. 68, January, 1859.

In the third volume of the *Geological Survey of Kentucky*, old series, page 472 *et seq.*, Mr. Lyon described, under the names *Asterocrinus capitalis* and *Asterocrinus coronarius*, the first species of the remarkable genus which we now have the means of somewhat more fully understanding, and of referring to a more definite place among the *Paleocrinidæ*.

In the article published in the *American Journal of Science and Arts*, to which reference is made in the synonymy above given, the name of the genus was changed to *Pterotocrinus*, that previously assigned to it proving to be pre-occupied ; and the authors, Lyon and Casseday, published three new species. In the descriptions of these some facts were added to the previous knowledge of this genus, and its generic formula was arranged as follows : Basal pieces, 2 ; radial pieces, 1st series, 5 ; radial pieces, 2d series, 10 ; radial pieces, 3d series, 20 ; anal pieces, 1 or more; mouth central, 1; column round (?); arms ciliated and single, 20 ; wings or lobed pieces, 5, variously formed.

Up to this time, or for a period of nearly twenty years, nothing further has been added to our knowledge of this anomalous genus, but few additional species having been referred to it, and part of these erroneously. It is now proposed briefly to review the whole subject, and to add such facts as have been derived from the study of a large series of specimens, some of which are far more perfectly preserved than any hitherto discovered, while others are broken or distorted in such a way as to show many parts of the structure in the most satisfactory manner ; so that we now have the means of adding such new facts as will render our understanding of this fossil comparatively complete.

THE BODY.

The body of this Crinoid consists of a saucer-shaped shallow cup in some species, or of a much deeper, sub-conical one in others. This arises from the different form of the pelvic plates in the various species

a difference which makes any generic formula, containing descriptions of these plates, subject to revision for each species to a certain extent, as their shape is by no means constant. The two basals are pentagonal, centrally excavated on their line of junction for the reception of the column, this excavation in some cases being so widened outwardly as to give rise to a deep cup in the center of the base, and to render the basals carinate on their dorsal surfaces, while in other species it is so small as to barely admit the slender column. When united, the anterior side, at the end of the suture joining them, contains an angular depression into which is fitted the corresponding face of the first radial on that side. The faces of the basals at the opposite end of the suture are similarly depressed for the reception of the azygos plate. The first radial of the anterior side is heptagonal, much wider than high, with a slight angle on the basal margin, the apex of which corresponds with the line of junction of the basals. It is excavated on the opposite face for the reception of the small second radials, the inner faces of which meet on a line over its center, resting upon which, and their excavated inner faces, is frequently a small, sub-pyramidal, accessory plate. The first radials joining the anterior one on either side are hexagonal, twice as wide as high, and similar in form and size to the anterior one, except that they join the basals by a single side instead of two. They bear no accessory plates in any of the specimens.

The two posterior first radials are heptagonal, and have their applied inner margins excavated in such a manner as to receive the convex sides of the azygos plate, above the outer extremity of which they unite, the suture being in an exact line with that of the basals.

The second radials are ten in number, longer than high, irregularly quadrangular, so far as can be determined, with the longer side resting upon the first radials, about one half of the central upper surface of which they cover. They present slight differences in the ratio of the height and breadth in the different species. Third radials twenty, subquadrangular, about twice as wide as high. As there are four to each of the first radials, two of them rest upon the second radials in the center of their upper faces, while the other two have their inner ends resting slightly upon the outer ends of the second radials, and their outer ends joining the uncovered extremities of the first radials. The form of these plates varies exceedingly in the different species, as they are sometimes more than twice as wide as high, while in some of the more conical species the two dimensions are nearly equal.

The azygos piece is pyriform or sub-pyramidal, slightly angular at its junction with the basals, and convexly rounded to a point at the opposite extremity, which is completely embraced by the first radials

in all the specimens examined. The brachial pieces are arranged in series of threes or fours on the third radials, and resemble them in form, except that the ratio of the height to the width is greater.

The Arms.

These are without bifurcations or divisions, composed of a double series of interlocking plates, forty to sixty in each series, gradually tapering to their extremities, and bearing two rows of stout, short, five or six jointed pinnulae. The arm-plates are deeply excavated centrally on the ventral surface by the ambulacral grooves, from which radii are continued into the pinnulæ. The arms are long enough to fold over the top into the space at the base of the interbrachial rays.

The Vault.

This is pyramidal and pentagonal in form, four of the sides being equal, while the fifth or azygos side is about one fourth larger than the others. It is composed of series of heavy plates, articulated in such a manner that the five angles are excavated for the reception of the inner ends of the interbrachial rays, which do not penetrate the vault, but are articulated to it at the five angles, and are held in place by the lower outer piece of the angle, which bears on its inferior, outer side, a hook-like process, locking into the lower inner edge of the ray. The sides of the vault are made up of series of pieces, differing much in shape and size.

The lower series consists of three pieces on each side of the vault except the azygos side which has four. These pieces, and those at the lower ends of the angles, comprise the base of the vault. They are folded inwardly, and in transverse section are shown to articulate below with the radials, as the inner side of the first radials is reflected upward to meet them. The sutures of these plates are perforated by the pores communicating with the arm furrows. These pores are slightly funnel-shaped, directed upward exteriorly, and excavate the second and third radials interiorly, opening into the pelvic cavity: So far as can be determined by numerous cut specimens, there is no skeletal division of the cavity inside either of the vault or pelvis, which, on such a supposition, was a shallow, saucer-shaped cup, terminated upward by a pentagonal pyramid. There is no dome roofing the pelvic cavity, and separating it from that of the vault. The latter, above the basal series of plates already described, is formed of hexagonal and pentagonal pieces, of different proportions in the various species, and is in some cases terminated by a number of small plates, the precise arrangement of which can not be determined. The top of

the vault of many specimens is capped either by a Mollusc,* or by a pentagonal plate. In the best preserved specimens, this plate has five carinated ridges radiating from a point on the azygos side of the center, and terminating in rounded protuberances at the peripheral angles, the two lying on each side of the azygos face being the largest. The bases of the interbrachial rays abut upon these protuberances, the upper side of the plate lying somewhat below them. The sides of this plate are slightly excavated between the five angles, the deepest excavation being on the azygos side. On breaking away one of the Gasteropods, I found the aperture of the shell to be applied over the upper end of the vault, and that the terminal plate was in position at its apex. In specimens not covered by these shells, it can be seen that the small lateral, terminal plates of the vault were not perforated, but there are evidences that the under side of the cap-piece was radially excavated, the excavations being indicated by the carinated ridges mentioned above; so that, if any summit openings existed, they must have been under the edges of the pentagonal cap-piece. These openings may be seen excavating the under surface of the protuberances at the angles of the cap-piece. It thus appears that the only openings of this Crinoid were those communicating with the ambulacral grooves of the arms, the anal (?) opening, and those at the apex of the vault. The inside of the plates of the vault and pelvis, gives no evidence of processes for the attachment of any skeletal framework, and it is probable that any such apparatus as it may have contained was membranous and perishable. It is also likely that ciliary currents, having entered the vault by the perforations at the base of the ambulacral grooves, were expelled by the openings at its summit, as there is a canal leading downward from beneath the cap-piece, and gradually increasing in size as the vault enlarges towards its base. The systems of radiating vessels so often traceable in many other Crinoids, are here represented only by the arm-furrows and the perforations of the vault, so far as at present determined.

The Interbrachial Rays.

Of these there are five, which are either spatulate, claviform, or cuneiform, with many variations of these types. In some of the species they are thin and knife-like throughout their length; in others,

* About one half of the specimens found have the top of the vault covered by a small species of *Platyceras*. A larger species is frequently found attached to the pelvis of *Platycrinus hemisphericus*, in such a way as to cover the azygos area. These Molluscs were evidently parasitic on the Crinoids, as the edges of the shells have so grown in position as to accommodate themselves to the sinuosities of the surfaces upon which they rest. It is more than probable that they fed upon the exuviæ of the Crinoid. At all events, the most perfect vaults yet found are those covered by these shells. Attention has been called to this subject by Prof Worthen, and it is certainly worthy of more careful examination.

thickened and rounded above and slightly thinner below; in some they terminate in thin, rounded edges; in others they are tapered down to an awl-like point, while yet others are slightly or widely bifurcate at the extremities. They are so articulated to the angles of the vault, that their inferior process divides the arms into groups of four, while their single or bifurcate extremities extend outside of the pelvis, having in some species a length beyond it equal to its greatest diameter. The lower process of these rays sometimes separates the arms down to the brachials, and sometimes only through the upper half of their extent. It is beyond conjecture what purpose in the physiological economy of the animal could have been served by them, as they were not needed for arm supports, and their position shows us plainly that they formed no part of the alimentary or reproductive systems. They are entirely homologous in position, in the fact of their articulation to the vault, and in separating the arms into equal groups, with the so-called axillaries of *Eucalyptocrinus*.* If the articulation to the lower plates in the angles of the vault shall prove to be in any way connected with furthur openings of the latter, their use may be traced to some of its functions; but this at present we have no means of determining. The articulation seems, in some cases, to have been by means of separate pieces rather than by processes.

The Column.

The small part of the upper portion preserved is very slender, round and composed of equal, very thin pieces. As but slight remains of it have been found, our knowledge is restricted to the above statements.

Remarks.

It will be seen from the description of this genus, and of the species placed in it by its authors, that the *Dichocrinus cornigerus* and *Dichocrinus sexlobatus* of Shumard can not be referred to it, as has been er-

* From a study of fine specimens of *E. crassus*, kindly loaned me by Dr. R. M. Byrnes, two of which are figured on the plate accompanying this article, it is evident that the interbrachial rays of *Pterotocrinus* are articulated to the vault in much the same manner as the axillary and interradial rays of *Eucalyptocrinus*. In the latter genus, the base of the vault is excavated at its angles, for the reception of the lower inner protuberance of these rays; these excavations are larger for the interradial than for the axillary rays. As they alternate, the arms are divided into groups of fours between each pair of axillaries or interradials. The ambulacral grooves are continued into the pelvic cavity through the openings in the basal pieces of the vault. The latter narrows upward, and opens at the apex by a small, central aperture, closed by five minute, pyramidal plates. Good casts of this species, from Cedarville, Ohio, now in my cabinet, show the arrangement of the rays and the openings of the pores in the bases of the arms most satisfactorily. One of these is figured with the specimens from Dr. B's collection. This figure will be readily understood by referring the elevations on the cast to depressions in the Crinoid, and *vice versa*. A full study of this genus, from numerous cut specimens, is in course of preparation, and will be published soon

roneously done, those species having the construction of *Dichocrinus*, and differing in every essential particular from *Pterotocrinus*. None of the species present any evidence of sculpture or ornamentation; nor do any of the many other fine Crinoids found associated with them. It might be supposed that this was the result of erosion, were it not for the fact that the many beautiful species of *Chætetes*, *Polypora*, *Fistulipora*, *Septopora*, etc., associated with them, have all their most delicate structure perfectly preserved. It must then be inferred that the *Crinoidea* of this group were plain species. The true formula of the genus is as follows: Basals, 2; radials, 1st series, 5; radials, 2d series, 10; radials, 3d series, 20; brachials, 3 or 4, x 20; axillaries or interbrachial rays, 5; anal plate, 1 or more (?); arms, 20; column small and round; exterior without ornamentation. Geological position: upper half of the Kaskaskia Group of the Sub-carboniferous, in sandy shales, Pulaski Co., Ky. The wide variation exhibited in the form of the different species of this remarkable Crinoid; the inconstant character of its plates; the different arrangement of the vault pieces at the apex; the strange and widely varying forms of the rays, are each evidences of the impossibility of arranging a generic formula that shall include all cases; but that given is as near perfect as can be. The almost entire anchylosis of the first and second radials in old individuals may easily lead one astray who does not study sliced specimens; while the varying form of the rays found, and not yet referred to discovered species, shows that there are large numbers of forms as yet unknown. It is plain that its nearest alliance is with *Eucalyptocrinus*, which has four basals, or a second division of those of *Pterotocrinus and Dichocrinus*. I am satisfied, however, that all classification of the *Crinoidea*, based merely upon the arrangement of the pelvic plates, will soon be superceded by the more rational one of the relationship of internal structure.

DESCRIPTIONS OF NEW GENERA AND SPECIES OF FOSSILS FROM THE LOWER SILURIAN ABOUT CINCINNATI.

By E. O. Ulrich.

In giving the formations in which the following species occur, the terms Utica shale and Hudson River Group are used instead of Cincinnati Group. The term Cincinnati Group was mainly established by Messrs. Meek and Worthen, on account of the supposed absence, in the Cincinnati exposures, of the Utica shale. The rocks exposed at High Bridge, Lexington, and many other localities in Kentucky, are

undoubtedly of the age of the Trenton ; and also, we believe, that the Black River limestone crops out at the Kentucky River, below High Bridge, Frankfort, and possibly at several other localities. The strata exposed at Cincinnati, from low water mark in the Ohio River to about seventy-five feet above that horizon, and which are considered by nearly all the geologists at Cincinnati to be referable to the Utica shale, differ from the strata above and below them lithologically, as well as in the fossils they contain. At least twenty-six species occur in them that are not known to have been found in the strata referred to the Trenton Group, nor in those of the Hudson River Group. These species are : *Buthrotrephis ramulosa*, Miller ; *Lockeia siliquaria*, James ; *Chætetes briareus*, Nicholson ; *Chætetes calicula*, James; *Dendrocrinus dyeri*, Meek ; *Graptolithus tenuis(?)*, Portlock ; *Dicranograptus ramosus*, Hall ; *Diplograptus whitfieldi*, Hall ; *Diplograptus spinulosus(?)*, Hall ; *Leptobolus lepis*, Hall ; *Modiolopsis cincinnatiensis*, Hall and Whitfield ; *Leperditia byrnesi*, Miller; eight species described in this paper : *Heterocrinus geniculatus*, *Dendrocrinus(?) curtus*, *Palæaster finei*, *Leptæna plicatella*, *Cyrtolites nitidulus*, *Leperditia radiata*, *L. bicertex*, *L. unicornis*, and six undetermined species; two crinoids, probably new, a *Leperditia*, a graptolite, a fucoid, and an undescribed species of Crustacean, allied to *Enoploura*. Although there is some intermingling of the species occurring in this western exposure of the Lower Silurian, on the whole, we believe that there are sufficient reasons for re-instating the old terms by which its subdivisions were known.

Genus Leperditia (Roualt).

Leperditia radiata, n. sp. (Plate VII., figs. 2, 2*a*, 2*b*.)

[Ety.—*Radiatus*, radiating.]

Length, 0.2 ; breadth, 0.17 inch.

Carapace from sub-quadrate to sub-reniform ; dorsal margin straight, nearly as long as the length of the valve ; anterior and posterior ends equal, either slightly truncate, or broadly rounded ; ventral margin convex. Valves depressed convex, with a slightly defined, rather broad marginal rim. Tubercle situated near the middle of the valve, small, sub-oval, and not very prominent ; substance of tubercle very thin, rarely preserved, the position of the tubercle usually being marked by a perforation in the valve. Surface minutely striate ; striæ radiating from four or five points on the valve ; the striæ composing the central group are the strongest, and radiate from the tubercle. In some specimens, the striæ show through the valve on the interior; in

others, the interior is smooth. Ventral margin of the right valve overlapping that of the left, and on the interior thickened and grooved, to admit the ventral edge of the left valve. Substance of the valves thin.

The form of the valves and their radially striate surface, will serve to readily distinguish the species from any other species of the genus known to the writer.

Formation and locality: The specimens were found in the Utica shale, exposed below the banks of the Ohio River, in the First Ward of Cincinnati.

Collectors: J. Fine, H. E. Dickhaut, E. O. Ulrich.

LEPERDITIA CREPIFORMIS, n sp. (Plate VII., figs. 3, 3*a*.)

[Ety.—*Crepis*, a horse-shoe; *formis*, form.]

Length, .02; breadth, .015 inch.

Carapace minute, broadly elliptical or reniform; dorsal margin straight or slightly convex, with hinge line much shorter than the entire length of the valve; anterior and posterior extremities subequal, rounded, the former end being sometimes slightly more obtuse than the latter; ventral margin uniformly rounded. Valves moderately convex. Tubercle or ridge arising abruptly, very prominent, and shaped like a horse-shoe, placed on the anterior half of the valve: the two sides of the "horse shoe" are rectangular to the dorsal margin, and extend from the same across the valve to the ventral margin; the anterior half of the ridge arises immediately from the anterior extremity; width of the ridge equal to about one fourth of the width of the valve; a deep sulcus, between the anterior and posterior halves of the ridge, extends from the dorsal margin to three fourths the distance across the valve. Surface smooth. Interior marked by a horse-shoe shaped depression corresponding to the ridge of that form on the exterior.

This species is too distinct to necessitate a comparison with other species of the genus.

Formation and locality: in the lower part of the Hudson River Group, at Covington, Ky.

Collector: E. O. Ulrich.

LEPERDITIA UNICORNIS, n. sp. (Plate VII., figs. 4, 4*a*, 4*b*.)

[Ety.—*Unicornis*, one-horned.]

Length, .035; breadth, .02 inch.

Carapace minute, sub-quadrate, or obtusely elliptical, rather narrow; anterior and posterior ends nearly equal, broadly rounded, valves very convex, with abruptly sloping margins, and cylindrical; dorsal edge

straight, nearly as long as the entire valve ; tubercle near the anterior extremity prominent, pointed, directed anteriorly, and in some specimens to such an extent, as to project beyond the margin of the valve; the posterior third is sometimes tumid, and in that case there is a broad, slightly defined depression or sulcus, about in the middle of the valve. Surface smooth, or minutely pitted. Color, black. Substance of valves thick. There is an internal pit corresponding to the anterior tubercle.

Leperditia (*Isochilina*) *cylindrica*, Hall, bears some resemblance to this species. It is, however, comparatively longer, more uniformly convex, somewhat different in outline, and with the tubercle obsolete.

Numerous valves of this species were found associated with *Leperditia minutissima* and *cylindrica*, Hall; *L. byrnesi*, Miller; *L. bivertex*, Ulrich; and *Leptobolus lepis*, Hall, in slabs of crystalline limestone, occurring within fifty feet of low water mark in the Ohio River, about one half a mile west of Covington, Ky.

Collectors: H. E. Dickhaut, E. O. Ulrich.

LEPERDITIA BIVERTEX, n. sp. (Plate VII., figs. 5, 5*a*.)

[Ety.—*Bivertex*, with two peaks.]

Length, .04; breadth, .03 inch.

Carapace minute, sub-reniform ; dorsal margin straight, over two thirds as long as the entire length of the valve ; anterior and posterior extremities equal in width ; ventral curve nearly uniform. Valves strongly convex. Tubercle at the anterior end, near the dorsal margin, large, rising abruptly, obtusely rounded, and slightly directed posteriorly. Posterior tubercle situated near the dorsal margin, and about half the length of the valve from the posterior extremity, less obtusely rounded, and more prominent than the anterior tubercle. Between the tubercles there is a deep sulcus, extending from the dorsal margin to one half the distance across the valve. Surface smooth. On the interior there is a corresponding pit for each tubercle, and a divisional ridge between them.

The species can be readily distinguished from *Leperditia byrnesi*, S. A. Miller, which it most resembles, by the form and relative positions of the tubercles. In that species the posterior tubercle is nearer the posterior margin, is much more prominent and pointed, and extends considerably beyond the dorsal margin. That species is also comparatively longer.

Formation, locality and collectors : same as the last.

Genus Beyrichia (McCoy).

Beyrichia persulcata, n. sp. (Plate VII., fig. 6.)

[Ety.—*Persulcatus*, strongly sulcated.]

Length of large specimen, .02; breadth, .015 inch.

Carapace very minute, sub-reniform to semi-circular, longer than wide, the proportions being about as three to four; dorsal margin straight, as long as the valve; anterior and posterior extremities subequal: valve marked by three transverse furrows, extending from the dorsal to the ventral margin, which are deeply and abruptly impressed, the central one being essentially central to the entire valve; anterior and posterior furrows at their ventral ends, curving slightly towards each other. The anterior, posterior, and posterior median lobes are nearly equal in size, the latter, however, is somewhat more prominent; the anterior median lobe is of the same general form and dimensions as the posterior median lobe, but is divided in the middle of its length into two nearly equal parts, by a narrow, deep, and very abrupt furrow. Surface smooth.

This is an exceedingly small and quite distinct species. It is probably most nearly related to *Beyrichia regularis*, Emmons, from which it is distinguished by its comparatively stronger ridges or lobes, and much more abruptly depressed sulci, as well as by having the anterior median lobe divided into two parts, instead of entire, as is the case in that species.

Formation and locality: found associated with *Leperditia crepiformis*, at Covington, Ky.

Collector: E. O. Ulrich.

Genus Cyrtolites (Conrad).

Cyrtolites nitidulus, n. sp. (Plate VII., figs. 7, 7*a*.)

[Ety —*Nitidulus*, neat, pretty.]

Shell below the medium size; volutions two or three, rapidly increasing in size, very slightly embracing; dorsum with a broad, flattened carina; sides strongly convex, rounding more abruptly into the umbilicus than to the periphery; umbilicus moderately wide and deep; aperture broadly cordate. Surface ornamented by rather fine, rounded, transverse striae, crossing the volutions from the umbilicus to the dorsum in a curved and obliquely backward direction; on the broad dorsal carina also the striæ make a short backward curve.

Greatest diameter of an adult example, 0.38 inch; convexity at the aperture, 0.2 inch; number of transverse striæ in the space of one tenth of an inch, near the aperture, from seven to nine.

This pretty little species is probably most nearly related to *C. carinatus*, Miller, but the strongly carinated sides of the volutions and the sharp keel in that species will distinguish them. The striæ also are different.

Formation and locality: the specimens examined were found in the layer of dark-blue limestone occurring in the Utica shale, and in which the *Modiolopsis cincinnatiensis*, Hall and Whitfield, abounds.

Collectors: H. E. Dickhaut, E. O. Ulrich.

Genus Microceras (Hall.)

Microceras minutissimum, n. sp. (Plate VII., fig. 8.)

[Ety.—*Minutissimus*, very small.]

Shell exceedingly small, discoid; volutions from two to three, rounded, not embracing, the last one nearly separate, and increasing moderately in size; umbilicus shallow, about one and a half times as wide as the dorso-ventral diameter of the outer volution at the aperture; aperture rounded, approaching sub-ovate; surface smooth.

Greatest diameter, 0.02 inch; convexity less than 0.01 inch.

This shell can easily be separated from *M. inornatus*, Hall, the other species of the genus. In that form the volutions increase much more rapidly in size, and are quite angular on the periphery and sides, while in the one under consideration they are rounded. Hall's species is also about three times as large. Another difference, which however may not be constant, is, that the shell of *M. inornatus* always has a dark-brown or black color; while all the specimens observed of this species are yellowish-white.

Formation and locality: found associated with *Cyclora minuta*, *C. depressa* and *M. inornatus*, at Hamilton, O., and near the tops of the hills at Cincinnati.

Collector: E. O. Ulrich.

Genus Cyclora (Hall).

Cyclora depressa, n. sp. (Plate VII., figs. 9, 9*a*.)

[Ety.—*Depressus*, depressed.]

Shell very small, sub-lenticular, about twice as wide as high; spire much depressed; volutions two or three, angular a little below the middle, increasing moderately in size, and with a barely perceptible convexity on the upper side; sutures deeply impressed; umbilicus large; aperture rhombic-oval; surface smooth.

Height of a specimen of the usual size, 0.02 inch; breadth, 0.04 inch.

This species differs from both *C. minuta* and *C. parvula*, Hall, in having a larger umbilicus, the spire much more depressed, and the whorls angular instead of rounded.

Formation and locality: found in great abundance in the Hudson River Group at Hamilton, Ohio.

Genus Zygospira (Hall).

Zygospira concentrica, n. sp. (Plate VII., figs. 10, 10*a*, 10*b*.)

[Ety.—*Concentricus*, concentric.]

Shell small, depressed, sub-equivalve, generally a little wider than long; posterior lateral margins straightened, and converging to the beaks at an obtuse angle; lateral margins rounded; front rounded or sometimes a little straightened. Dorsal valve with a shallow, undefined mesial sinus of moderate breadth at the front, but becomes obsolete before reaching the umbo; surface on the sides of the sinus gently convex, and sloping to the lateral margins; beak rather prominent and slightly incurved.

Ventral valve with a low mesial ridge, most prominent near the middle of the shell, on each side of the ridge the slopes are somewhat depressed; beak small, pointed, projecting beyond that of the other valve, and strongly incurved; foraminal aperture very small, round, and situated just under the apex.

Surface ornamented by rather distant but well-defined striæ of growth: sometimes 6 or 8 very obscure radiating folds or plications are observed; in that case two occupy the mesial ridge and one the sinus.

Length of medium-sized specimen, 0.18 inch; width, 0.2 inch; greatest convexity, 0.12 inch.

The outlines of *Zygospira modesta*, Say, are quite similar to those of this shell; that species has, however, from 16 to 20 strong and angular radiating ridges, and only very rarely has the fine and crowded concentric lines preserved; but in this species there are generally no radiating plications (when any do exist, they are only rudimentary), while the concentric striæ are well developed; besides, the posterior lateral margins are straighter, and the beak of the ventral valve is more pointed, than in that shell.

Formation and locality: found in the lower part of the Hudson River Group, on the hills about Cincinnati, at an elevation of from 300 to 350 feet above low water mark.

Collectors: W. Gault, W. E. Cook, E. O. Ulrich.

ORTHIS? SECTOSTRIATA, n. sp. (Plate VII., figs. 11, 11*a* and 11*b*.)

[Ety.—*Seco*, to cut, to divide.]

Shell attaining medium size, sub-circular ; valves nearly equally convex. Dorsal valve convex, its greatest prominence being near the middle of the valve; a slight mesial ridge runs from the umbo to the anterior margin; beak short and incurved. Ventral valve with greatest convexity a little posterior to the middle; mesial sinus but slightly defined; beak very prominent, obtusely pointed, and quite strongly incurved upon that of the other valve. Surface ornamented with from thirty to thirty-five fine, even, radiating striæ, all of which bifurcate once near the center of the valves, making the number at the anterior margin about seventy. On well preserved specimens, when viewed through a magnifier, the surface exhibits very fine and crowded concentric lines.

Length of a medium sized specimen.

The generic affinities of this specis can not, at present, be positively determined, since its interior is as yet unknown. It is possible that it should be placed into the genus *Zygospira*, Hall, as it externally much resembles *Zygospira headi*, Billings. From *O. ella*, Hall, it is distinguished by its circular outline, much finer and bifurcated striæ; the beak of the ventral valve is much more incurved upon that of the dorsal valve, than is the case in *O. ella*.

Formation and locality: the species is not common, and occurs in the Hudson River Group, on the hills back of Cincinnati, Ohio, at an elevation of about three hundred and seventy-five feet above low water mark in the Ohio River.

Collector: the specimen figured was found by Mr. Stanage. A number of specimens have been found by other collectors.

Genus LEPTÆNA (Dalman).

LEPTÆNA PLICATELLA, n. sp. (Plate VII., figs. 12, 12*a*, 12*b* and 12*c*.)

[Ety.—*Plicatella*, a small plait or fold.]

Shell very small, semi-oval, approaching semi-circular, concavo-convex ; hinge line sometimes only as long as the greatest breadth of the valves, but generally its length is greater than the breadth of the shell; lateral extremities varying from acutely angular to rectangular, and not reflexed ; anterior and lateral margins forming together nearly a regular semi-circular curve.

Ventral valve rather strongly convex, being almost evenly arched along the middle from the beak to the front; beak very small, scarcely distinct from the cardinal margin; area moderately developed, twice as high as that of the other valve, inclined slightly backward; foramen

arched over, near the beak, by a small pseudo-deltidium. Interior showing cardinal teeth to be small; muscular impressions undefined.

Dorsal valve concave, with deepest concavity near the middle, and following so nearly the curve of the ventral valve as to leave but a very thin visceral cavity within; beak not distinct from the cardinal margin: area very narrow, and ranging at right angles to the plane of the valves. Interior of this valve not observed. Surface of both valves marked by distinct, sub-angular, radiating plications, some of which bifurcate once or twice, at about the middle of their length. Near the free margins the striæ number from eighteen to twenty-five.

Length of a mature specimen, 0.13 inch; breadth, 0.25 inch; convexity, 0.06 inch.

From young specimens of *L.* (?) *serciea*, Sowerby, this species is distinguished by having comparatively strong plications instead of the exceedingly fine striæ of that species; and in having a greater convexity.

Formation and locality: in the Utica shale, associated with *Triarthrus becki*, at Cincinnati, O., and Covington, Ky.

HETEROCRINUS GENICULATUS, n. sp. (Plate VII., figs. 13, 13*a*, 13*b*, 13*c*.)

[Ety.—*Geniculatus*, jointed, geniculated.]

Body small, obconic, and slightly longer than wide. Basal pieces pentagonal, about as wide as high, or a little wider. First radial plates in four of the rays, convex, about as wide as high, and pentagonal in form: each supporting on its upper side a considerably larger sized second radial, that is quadrangular in outline, with a length and width about equal: in the right posterior ray, this piece is slightly truncated for its articulation with the first plate of the azygos or anal series; third radial in these rays a little smaller than the second, wider than long, and contracted at the upper end to about two thirds of the length of the lower side; these support a somewhat smaller, regularly pentagonal fourth radial, the two lateral edges of which are not parallel, but converge toward the inferior end; this is an axillary piece, and bears two arms on its upper sloping faces. First radial in the fifth or right lateral ray comparatively large, obscurely pentagonal in outline, and longer than wide, having a length that is nearly equal to the combined height of the first and second radial pieces in the other rays; this piece supports a second radial which in form and size is the same as the third radial in the other rays; above this is an axillary piece, which bears two arms on its superior sloping sides, and in form and size is similar to the axillary or fourth radial plates of the other series of primary radials. Arms, from their origin on the third and fourth radials, simple through-

out, rounded, rather slender, and composed of elongate, somewhat wedge-shaped joints; from which proceed strong, jointed pinules, from near the upper margin of their longer sides. These arm plates are much enlarged at the origin of the pinules which are alternate on the opposite sides of the arm, giving the rays a peculiarly roughened aspect and tortuous direction. The pinules appear first on the third and then on the sixth piece of the secondary radials, above which each succeeding plate is provided with one. In some specimens each second or third piece, above the sixth plate of the secondary radial series, appears to be divided into two; in that case the lower and smaller piece is without a pinule.

The first azygos inter-radial, or anal piece, is wedge-shaped, with its base resting upon the superior lateral sloping side of the second radial of the right posterior ray. Above this there is a direct vertical range of pieces, much rounded on the outer side, and reaching nearly to the extremities of the arms. The ventral prolongation is formed by thin extensions of these pieces, which proceed from their sides. The width of these extensions is about one-sixteenth of an inch, more or less.

Column of medium size, round, tapering downward from the calyx, near which, and to one and a half inches below the same, it is composed of alternately thicker and thinner disks, the thicker ones being slightly prominent at the edges; the rest of the column, as far as observed, is nearly smooth, and composed of rather thin, sub equal disks.

The peculiarly roughened and tortuous rays of this species, which in that respect remind one strongly of a number of sub-carboniferous species of *Poteriocrinus* and *Scaphiocrinus*, will serve to distinguish it from all the other species of the genus known to the writer. *H. laxus*, Hall, has this peculiarity developed in a small degree. Otherwise it differs from this species in having a proportionally longer and more angular body, and shorter arm pieces; while the armlets or pinules are proportionally stouter, much shorter, and are given off at longer intervals. The column and calyx of *H. simplex*, var. *grandis*, Meek, are much like those parts in this species, but the very different structure of the arms in the two forms, and the different outlines of the third and fourth primary radials, and the absence of a ventral prolongation in *H. simplex*, clearly show that they are distinct.

Formation and locality: the specimens used in the description were found in the Utica shale, at Cincinnati, O., within fifteen feet of low water mark in the Ohio River.

Collected by J. G. Fine, S. A. Miller, E. O. Ulrich.

DENDROCRINUS (?) CURTUS, n. sp. (Plate VII., fig. 14.)

[Ety.—*Curtus*, short.]

Body truncato-obconic, short. Basal pieces very short, more than twice as wide as high. Sub-radial pieces moderately large, rather obscurely hexagonal, with a width equal to one and a half times the length. First radial pieces, in the three rays exposed, a little larger than the sub-radials, about as long as wide, and pentagonal. Right posterior ray with the second piece a little larger than those of the other rays, about as large as the sub-radials, nearly as long as wide, sub-pentagonal in outline, with the two superior sides sloping, so as to give the appearance of an axillary piece, but the right, shorter slope merely supports the first anal piece ; while from the left continue the succeeding true radials, of which there are six, somewhat shorter, smaller pieces in direct succession, the sixth one being axillary, and supporting the first divisions of the arm. In the ray immediately to the right of the one just described, there are ten pieces (counting the first radial) in direct vertical succession, which, above the first radial, have a width that is nearly equal to twice the length ; the tenth piece appears to have been an axillary, but this can not be satisfactorily determined, on account of the imperfect condition of the specimen at that point.

The left posterior ray presents six pieces, between the first bifurcation and the first radial, that are shorter than in the other rays. Arms moderately long and rather stout, acutely rounded on the dorsal side, and concave on the inner side, giving off, alternately, on opposite sides at rather distant intervals above the first bifurcation in each ray, from four to five, or more, scarcely diverging divisions, that are about half as stout as the main arm from which they spring, and composed of pieces that are about as wide as long, and prominent at the superior lateral angles ; these armlets remain simple throughout ; the first bifurcation of the rays is in all respects similar to the succeeding ones.

Azygos inter-radials or anal series, consisting of a direct vertical range of pieces, that are longer than wide, not so wide as the primary radials, very convex on the outer side, and rise from the right superior sloping side of the second radial of the right posterior ray, so as to present much the appearance of a branch of this ray ; ventral prolongation and its connection with the anal series not observed.

Column large, round, nearly smooth, increasing very slightly in size downward, and composed of nearly equal, thin joints ; the disks have a small, central and circular perforation, radiating from which there are fine striæ.

The large columns of this species are quite abundant in the lower twenty-five feet of the Utica shale, as it is exposed on the banks of the Ohio River at Cincinnati. Much search has been made for the body, but without success, so far as the writer is aware, until the specimen used in the description, and figured, was found by Mr. J. G. Fine. Unfortunately, the specimen received a fracture, about one-half an inch above the top of the column, when the piece of shale in which it occurs was opened, and now (above the fracture) only shows the inner portion of the arms of the anterior side. The column and body are considerably compressed, but the plates in the latter seem to retain their relative positions very well. The first radials appear to be free, but this appearance very likely has been produced by pressure. The second radial is almost certainly free, except in the right posterior ray, in which that piece articulates with the first anal plate. In that respect, it approaches very near to *Cyathocrinus*, in which the second radial is entirely free. This peculiarity, in connection with others, has induced me to place the species only provisionally under *Dendrocrinus*, until other specimens can be found which will better show the characteristics of the species.

In the form and structure of the calyx, below the radials, *D. (?) curtus* is somewhat like both *D. rusticus*, Billings, from the Trenton, of Canada, and *D. Oswegoensis*, Meek and Worthen, from the Cincinnati Group of Illinois, but in the form of the primary radials, in the structure of the arms, and in the position of the anal plates there is considerable difference. There is no species found in the vicinity of Cincinnati to which it is near enough related to necessitate comparisons.

Formation and locality, same as the last.

Paleaster finei, n. sp. (Plate VII., figs. 15, 15*a*, 15*b*.)

Small; rays five, of medium length, rather broad, pointed, and narrower where they are attached to the much contracted body, than they are about the center of their length.

Dorsal side of rays composed of four rows of pieces, that are quite close fitting, as wide as long, from twelve to fourteen in each row, and increase in size inward to the disk, which is composed of irregularly shaped and prominent pieces, some of which are smaller and others larger than those composing the rays; the pieces in the marginal rows are more prominent than the two rows between them, and have a small pit in the center, probably for the articulation of a spine. Madreporiform body rather small, circular, very prominent, and marked by strong

striæ, which become more numerous toward the margin by intercalation.

Marginal pieces on the ventral surface, convex, quite as long as wide, and numbering in different specimens on each side from eleven to twelve; the piece at the junction of the rays is three times as large as any other of the series, sub-circular, and very convex.

Adambulacral plates more prominent, slightly wider than long, and numbering, on each side, from nine to ten. Ambulacral pieces a little wider than long, not alternating with the adambulacral plates, and each provided with a rather sharp ridge across most of its width.

There are ten oral plates formed by the junction of the adambulacral rows, which in form and size are scarcely distinguishable from the other plates of those series.

Greatest breadth measuring between the opposite extremities of the rays, 0.7 inch ; breadth of rays at their inner ends, .1 inch ; length of same, 0.3 inch ; diameter of madreporiform piece, 0.02 inch.

This species is related to *P. matutinus*, Hall, but has proportionally shorter rays, is smaller, and has four rows of pieces on the dorsal side of the rays instead of three. That species has a circle of stellately marked pieces on the dorsal side of the disk, which feature is not present in the species under consideration. The madreporiform body is also different. *P. incomptus*, Meek, has proportionally much shorter rays, larger disk, only three series of pieces on the dorsal side of the rays, and a much less convex madreporiform piece.

In the cabinet of the author there is a complete specimen with but four rays, which in all other respects is identical with the specimens used in the description.

Named in honor of the discoverer, Mr. J. G. Fine.

Formation and locality: in the Utica slate that is exposed near low water mark in the Ohio River, at Cincinnati, O.

INCERTA SEDES.

LEPIDOLITES, n. gen.

[Ety.—*Lepis*, a scale; *lithos*, a stone.]

This generic name is proposed for the reception of some very peculiar fossils, obtained by Mr. H. E. Dickhaut and the author, near Covington, Ky., on and in the shale immediately surrounding some of the hard clay nodules, which frequently occur in the shales of the lower part of the Hudson river group. They consist of much flattened, calcareous bodies, which in their original state must have had, in the type

species, a sub-spherical, and in the other species, a sub-cylindrical form. They are hollow, with a thin envelope of imbricating plates or scales. The lower (? end has an outside indentation similar to that borne by an apple for the reception of the stem, while the corresponding part of the interior is raised into a small cone. The interior of the sack appears to be lined with a very thin and delicate integument, to the outer surface of which the scales are attached. No openings of any kind can be detected.

Type: *L. dickhauti.*

In the imbricating plates some resemblance is presented to such genera of the Palæchinidæ, as *Lepidesthes*, but these fossils can scarcely be referred to the Echinodermata, on account of the entire absence of openings, and of any series of plates that might be termed ambulacra. The genus seems, in certain characters, to be related to *Pasceolus*, which by some authorities is considered to be a Cystidean, while others place the genus with the Protista. On account of the unique characters of the specimens on which the genus is founded, I have thought it advisable to describe them, provisionally, as fossils with uncertain affinities. However, I have no doubt, that when these characters are better understood, that the genus will be the type of a new family, if not indeed of a new order.

Lepidolites dickhauti, n. sp. (Plate VII., figs. 17, 17*a*, 17*b*).

All the specimens of this species examined are exceedingly flattened, but their original form undoubtedly was either sub-spherical or sub-pyriform, with the lower portion considerably indented. The envelope of scale-like plates is very thin, being little more than one-hundredth part of an inch in thickness, and appears to have been slightly flexible. The plates imbricate, with the exposed margin rounded, and arranged in concentric lines crossing each other in a quincuncial manner; they are much smaller about the indented portion, gradually becoming larger as the rows approach the upper portion. The appearance presented by a specimen that is flattened vertically, is very like that style of ornamental work on watch-cases called "rose engine turning." In the largest plates observed, the exposed portion has a diameter that is not more than one thirty-secondth of an inch. Detached plates have a length that is equal to about three times the greatest breadth, and are somewhat cuneiform in outline, the widest end being that one which is exposed on the exterior of the sack. When the exceedingly deli cate integument lining the interior of the sack, and to the outside of

which the plates are attached is removed, the lower ends of the plates are exposed; this side of the plates is provided with a slightly defined, longitudinal furrow.

Specimens of this species are usually coated with iron, which effectually destroys their minute characters. Fortunately, the author found some fragments that were entirely free of that troublesome substance, and from these the details of the above description were obtained.

Named in honor of the energetic collector, Mr. H. E. Dickhaut.

Formation and locality: the specimens were found in the shales of the lower part of the Hudson River Group, at Covington, Ky. Elevation, about one hundred and fifty feet above low water mark in the Ohio River.

LEPIDOLITES ELONGATUS, n. sp. (Plate VII., fig. 16).

(Ety.—*Elongatus*, elongated.)

This species differs from the type of the genus mainly in its different form. The form of *L. dickhauti* is sub-spherical, while that of the species under consideration is sub-cylindrical, with the ends usually somewhat truncated. The length is generally equal to about three and a half times the diameter or transverse measurement. The specimens are coated with iron, and for that reason I was unable to ascertain whether the plates differ from those of the type species. Their arrangement is very much the same.

This species seems to have attained a larger size than *L. dickhauti*. The largest specimen found, though defective at both ends, in its flattened condition is nearly two inches in length, by three-fourths of an inch in width.

Formation, locality and collectors: same as the last.

ORTHODESMA SUBOVALE, n. sp. (Plate VII., fig. 18).

[Ety.—*Sub*, somewhat; *ovale*, oval.]

Shell exceedingly thin, moderately elongate, subovate, the length equal to twice or twice and nearly a half the greatest height; cardinal and basal margins sub-parallel; cardinal line straight for one-half the length of the shell posterior to the beaks, beyond which point it gradually curves downward to near the posterior extremity, which is rather abruptly rounded or slightly truncate; anterior end short, equal to less than one-fifth of the entire length of the shell, very slightly contracted beneath the beaks, and more regularly rounded than the posterior margin; beaks small and somewhat pointed. Surface of the valves

with a faint, scarcely perceptible umbonal ridge, anterior to which there is a broad, very shallow and undefined depression, crossing the valves from the beaks toward the basal line, and becoming obsolete before reaching it. Internal markings not preserved in the specimens examined.

Surface of the valves marked by fine concentric striæ, and by some stronger undulations.

This shell is allied to *Orthodesma parallelum*, Hall, but that species has the anterior end more contracted, the shell proportionally longer, and the cardinal and basal margins are straight for a greater distance than in *O. suborale*.

Formation and locality: the specimens were found by me in the Hudson River Group, at Morrow, O.

Genus Tellinomya, (Hall).

Tellinomya cingulata, n. sp. (Plate VII., figs. 19, 19*a*.)

(Ety.—*Cingulata*, encircled with lines.)

Shell of medium size, nearly circular, with a slight prolongation of the posterior end, thus giving a little obliquity to the shell; anterior and basal borders regularly rounded; posterior cardinal margin slightly rounded and sloping to point of greatest extension; beaks small, obtusely pointed, and not incurved; valves moderately convex, somewhat depressed just posterior to the beaks, and along the cardinal margin.

Hinge plate wide, regularly, and rather strongly arched, occupied by eight to ten teeth on each side of the middle, those at the extremities bent to about a right angle, becoming more and more straight toward the center.

Surface ornamented by from six to eight very fine concentric lines.

Muscular impressions and pallial line not observed.

Length, 0.72 inch; height, 0.68 inch; convexity, 0.22 inch.

This species is related to *T. pectunculoides*, Hall, but its more circular form, less prolonged posterior border, the fine concentric striæ and its larger size, will serve to distinguish them externally, while its smaller number of teeth, wider hinge-plate, and more abrupt curvature of the same, will separate them internally.

Formation and locality: in the upper part of the Hudson River Gr. at Marble Hill, near Madison, Ind. The type specimens were found by Mr. H. Nettleroth, of Louisville, Ky.

NUCULITES YOLDIAFORMIS, n. sp. (Plate VII., fig. 20).

Shell small, extremely elongate, about three times as long as high: hinge line straight; beaks small, not prominent, somewhat pointed, and situated about three-eighths of the length of the shell from the anterior extremity; posterior end acutely pointed; margin of anterior end, below its junction with the cardinal line, regularly rounded; basal line gently curved, slightly sinuate or straightened posterior to the middle of the shell; an undefined and very shallow sulcus crosses the shell obliquely from below the beaks toward the posterior basal margin, causing the straightening of the basal line; cardinal slope narrow, carrying two folds or ridges, which originate just behind the beaks, extending to the posterior extremity, and gradually becoming heavier until that point is reached.

A strong clavicle extends from the anterior cardinal line, just in front of the beaks, nearly to the anterior basal margin.

Surface marked with very fine concentric lines.

It is quite impossible to confound this species with any other lamellibranchiate shell found in the Hudson River Group.

Formation and locality: in the shales of the lower part of the Hudson River Group, at Covington, Ky.

Collectors: H. E. Dickhaut, E. O. Ulrich.

PTERINEA MUCRONATA, n. sp. (Plate VII., fig. 21).

(Ety.—From *mucro*, a sharp point).

Shell small, broadly semi-cordate in outline, with hinge-line much longer than the body of the shell; greatest length generally nearly twice the breadth; anterior side gently and regularly convex, forming an angle of about seventy-five degrees with the hinge line; posterior side very slightly concave, or straight below the angle, and gently convex in the lower half, forming an angle of forty degrees with the hinge line; posterior wing compressed, extended into a rather long, acute point, and in most specimens is scarcely distinguishable from the rest of the posterior portion of the shell; there is no wing at the junction of the hinge with the anterior margin, the shell at that point usually being rounded or obtusely angulated; basal margin regularly rounded. Left valve moderately convex below and at the umbones; beak small, very slightly or not at all elevated above the hinge, and situated between one fourth and one fifth of the length of the hinge line from the anterior angle. Right valve not observed. In very young specimens the hinge line is comparatively shorter than in the adult examples.

Surface of the left valve marked by fine concentric lines, and at irregular intervals by rather strong furrows.

Length of large example, one half an inch; width, one quarter of an inch or a little more; convexity of left valve about one sixteenth of an inch.

The peculiar outline of this species will at once distinguish it from any other form known to the writer.

Formation and locality: in the soft shales of the lower fifty feet of the Hudson River Group, at Covington and Constance, Ky.

Collectors: H. E. Dickhaut, E. O. Ulrich.

CLEIDOPHORUS ELLIPTICUS, n. sp. (Plate VII., fig. 22).

Shell small elliptical, moderately and evenly convex; beaks a little more than two fifths of the length of the shell from the anterior end; umbones very little elevated; anterior and posterior margins regularly and evenly rounded; cardinal and basal lines both gently curved; clavicle slightly curved forward, and extending obliquely from in front of the beak to a point more than half the distance to the anterior basal margin.

Surface marked by very fine sub-equal concentric striæ.

Height of medium sized specimen, 0.18 inch; length, 0.3 inch; convexity, 0.1 inch.

This species is allied to *C. suboratus*, Hall, described from the Arisaig Formation of Nova Scotia, but that shell is larger, has different striæ, the beaks situated near the anterior extremity, and a shallow sinus.

Formation and locality: this species was found by Mr. Henry E. Dickhaut in the lower part of the Hudson River Group, at Covington, at an elevation of about one hundred and fifty feet above low water mark in the Ohio River.

CLEIDOPHORUS MAJOR, n. sp. (Plate VII., fig. 23).

(Ety.—*Major*, large).

Shell sub-ovate, ventricose, height and length respectively as $5\frac{1}{2}$ to 10; umbones rounded and prominent; beaks elevated, sub acute about one-fourth the entire length of the shell from the anterior margin; posterior cardinal line nearly straight, with a strongly defined sharp, umbonal ridge extending from the beaks and gradually becoming obsolete toward the posterior margin; the space between the ridge and cardinal line slightly depressed; anterior margin rounded; basa

margin broadly, but regularly rounded; posterior end rather narrowly rounded.

Surface unknown. The interior, as shown in casts, presents a deep triangular groove just anterior to the beaks, and passing, for a distance a little more than one third of the heighth of the shell, toward the anterior basal margin; the anterior muscular scar is distinctly defined, ovate, and situated immediately in advance of the groove; the posterior scar is rather large, sub-circular, and placed on the umbonal ridge (in the cast of the interior) about in the middle of the distance from the beaks to the posterior basal margin; pallial line obscure. simple, and running nearly parallel with, and considerably within, the basal border.

This is the largest species of the genus.

It is most nearly related to *C. elongatus*, Hall, from Nova Scotia. That shell however is sinuate, has the cardinal margin rounded and not straight, the beaks closer to the anterior margin, and has the clavicle bent and proportionally longer than in our species.

Formation and locality: Hudson River Group. Not rare on the hills back of Cincinnati, O.

CRISIDÆ.

Ropalonaria, nov. gen.

[Ety.—From *ropalon*, a club.]

Polyzoary creeping, adnate, branched, and forming a close and delicate network. Branches linear; cells uniserial, elliptical, joined together at their contracted ends. This genus is related to *Hippothoa*, but in the form and arrangement of the cells they differ widely.

Ropalonaria venosa, n. sp. (Plate VII., figs. 24, 24*a*.)

[Ety.—*Venosus*, full of veins.]

Polyzoary creeping, adnate, branched, and forming a very delicate network. Branches linear, with a straight central stripe or series of cells, which has two branches springing, usually from every junction of the cells, though sometimes at that of the second with the third; these branches are again divided in a similar manner, and anastomose: this peculiar mode of growth gives the polyzoary very much the appearance of the venation in a leaf. Cells uniserial, long, acutely elliptical, and joined together at their contracted ends, length of cells somewhat variable, but generally about four occupy the space of two

lines. Cell mouths not clearly determined, but appear to be situated near the middle of the cell.

This form has only been observed, incrusting *Streptelasma corniculum.* On account of the great delicacy of the fossil, the fronds themselves are rarely found, but instead we find a series of impressions on the exterior coat of the *Streptelasma*, which very well represent the fronds and cells of the same.

Formation and locality: the type specimens were found in the upper part of the Hudson River Group, at Clarksville, Ohio

Collectors: H. E. Dickhaut, E. O. Ulrich.

CHÆTETES COMPRESSUS, n. sp. (Plate VII., figs. 25, 25*a*, 25*b*).

[Ety.—*Compressus*, compressed.]

Polyzoary composed of small, very thin fronds, carrying the cell mouths on both sides; thickness of fronds varying from one half a line to one line.

Surface smooth. Tubes slightly oblique to the surface, opening by somewhat elongated apertures. Cell orifices nearly of equal size, circular to oval, and arranged in diagonal rows, eight to ten occupying the space of one line; occasionally a small septal tooth is developed in some of the tubes, projecting from the wall into the aperture. Intercellular space of variable thickness, apparently occupied by but few minute cells.

In longitudinal sections the tubes are short and approach the surface in a regular curve, a line drawn from the commencement of a tube to the aperture, forming an angle of about forty-five degrees with the surface; in the center of the frond the tubes are crossed by remote tabulæ, but as they near the surface the diaphragms become much more numerous, and here they are placed one third tube diameter apart. A few of the tubes are divided into halves by a delicate, wavy, vertical septum ; in one half of the tube the tabulæ are always more or less curved, while in the other half they are straight.

The general aspect of this species is somewhat like that of small specimens of *C. paronia* and *C. decipiens*, but those species grow in double leaves, with a divisional lamina between them. In the shape and arrangement of the tubes they are also different. It is so easily distinguished from the other frondescent species of the genus, that no comparison with any of them is necessary.

Formation and locality : the specimen figured is from the cabinet of the author, and was found by Mr. J. Nicklas, at Cincinnati, Ohio.

Fistulipora flabellata, n. sp. (Plate VII., figs. 26, 26*a*, 26*b*.)

[Ety.—From *flabellum*, a fan.]

Polyzoary forming irregular, fan-like expansions, carrying cell mouths on both sides. Thickness usually varying from one to two lines. Surface sometimes raised into broad and inconspicuous monticules, carrying tubules of the ordinary size. Cells oval, with apertures a little arched, arranged in bent and rather irregular rows; about five cells occupying the space of one line, the distance between them being equal to a little more than their diameter.

Intertubular space occupied by a great number of minute cells, which are nearly equally distributed between all the tubes of larger or ordinary size.

Longitudial sections show the tubules to be nearly vertical in the middle of the polyzoary, and then gradually bending outwards to the surface. Tabulæ are very sparingly developed. These sections clearly demonstrate that the interstitial tubuli observed on the surface, are not of the nature of a coenenchyma, but are only aborted cells. They are developed only near the surface. In the central portion of a transverse section, the tubes are angular, of unequal size and irregular form, with no minute tubuli between them.

Formation and locality : this species is found quite common at a height of 400 feet above low water mark, in the Ohio River, at the quarries back of Cincinnati, O.

Inocaulis arbuscula, n. sp. (Plate VII., figs. 27, 27*a*.)

[Ety.—*Arbuscula*, a little shrub.]

Frond small, originating in a single stripe at the base, diffusely branched and spreading above; branches narrow, and varying somewhat in width, the strongest not exceeding two hundredths of an inch, with strong, projecting, prong-like processes rising from the sides at frequent, but variable intervals; bifurcations numerous, not at equal distances. Substance of the frond thin, carbonaceous ; the surface is marked with faint, longitudinal, or slightly diverging corrugations, irregularly distributed over most parts of the branches ; the free extremities of the branches are usually pointed.

The surface corrugations on this species are much like those seen on some species of *Dictyonema*, but the mode of growth and the entire absence of connecting filaments, will at once distinguish it from species of that genus. *Inocaulis bella*, Hall and Whitfield, from the Niagara Group, is closely related to this form ; that species is, however, more

robust, and has the prongs projecting from the sides of the branches more numerous.

Formation and locality: in the soft shales of the lower portion of the Hudson River Group, at Covington.

Elevation of strata about one hundred and fifty feet above low water mark in the Ohio River.

Collectors: H. E. Dickhaut, E. O. Ulrich.

CRATERIPORA, nov. gen.

[Ety.—*Crater*, a bowl; *pora*, a pore.]

Attached to foreign substances, usually forming small, but sometimes quite large expansions, with a deep, cup-like depression in the central part; the latter feature imparting to specimens of the species, much resemblance to crinoid bases or roots; and composed of minute canals radiating irregularly from the cup, and passing obliquely to the surface. Spiculæ not observed.

Type: *Crateripora lineata.*

This genus includes several species, which occur in circular or expanded forms, presenting a minutely striated or pitted surface. Although I have examined a large number of good specimens, many of which were cut for examination with the microscope, we are not altogether certain that the genus should be referred to the sponges. It possesses characters entirely peculiar, and probably is a true Paleozoic type.

CRATERIPORA LINEATA, n. sp. (Plate VII., figs. 28, 28*a*.)

[Ety.—From *linea*, a line.]

Generally growing parasitically upon foreign bodies, but apparently was sometimes free, consisting of small patches, from two to four lines in diameter, usually circular, at other times with the outer margin irregular. The cup in the center is provided with a raised margin, and has a diameter one fourth that of the entire specimen. Radiating from the cup are very fine thread-like striæ, the number of which is increased as the margin is approached by interpolation. Upon close examination, they prove to be elevated ridges separating the rows of canal apertures. In the cup the apertures are also placed between raised lines radiating in every direction from the middle. From fourteen to sixteen rows occupy the space of one line. Sections taken at a right angle with the surface show the canals in the middle of the expansions to proceed upwards from the base, and terminating in the cup, while the others take an obliquely-outward course to the surface.

Formation and locality: not an uncommon fossil in the lower three hundred feet of the Hudson River Group, as exposed at Cincinnati, O.

Crateripora lineata, var. expansa.

[Ety.—*Expansa*, expanded.]

The specimens upon which this variety is established are attached to an *Endoceras*, and form rather large expansions, the largest examined covering the *Endoceras* for the distance of two and a half inches. The cup-like depressions are from half an inch to an inch or more distant from each other, over one line in diameter and about one half a line in depth, with a secondary, very shallow depression surrounding them, having a diameter of two lines. The canal apertures are arranged between raised lines, the same as in the typical examples of *C. lineata*, but where the specimens are well preserved the ridges are ornamented with a row of small granules.

This form may be distinct from *C. lineata*, but the material at hand is not sufficient for a satisfactory determination of that point. At any rate it is an easily distinguished variety of that species.

Formation and locality: in the middle part of the Hudson River Group, at Hamilton, O.

Collector: E. O. Ulrich.

Crateripora erecta, n. sp. (Plate VII., figs. 29, 29*a*.)

[Ety.—*Erecta*, erect.]

This species grows parasitically upon foreign substances (usually upon *Chætetes mammulatus*), and consists of small, circular, or somewhat irregular bodies, having much of the form of the type, *C. lineata*. excepting that the margin of the central depression is not raised. The cup has a diameter equaling one seventh of that of the entire specimen. The upper surface is covered with the openings of minute canals, of different sizes, irregular shapes and arrangement, apparently passing with but little obliquity from the lower or attached portion, to the upper surface. About fifteen canal apertures occupy the space of one line. Diameter of expansions from one to two and a half lines.

This species is distinguished from either of the preceding forms by its smaller size, comparatively smaller cup, its irregular arrangement of the canals, and in having the latter more erect in their course from the base to the upper surface,

Formation and locality: the type specimens were found in the Hudson River Group, at Cincinnati, O., at an elevation of four hundred feet above low water mark in the Ohio River.

Collectors: H. E. Dickhaut, E. O. Ulrich.

REMARKS UPON THE KASKASKIA GROUP, AND DESCRIPTIONS OF NEW SPECIES OF FOSSILS FROM PULASKI COUNTY, KENTUCKY.

By S. A. Miller, Esq.

The fossils described in this article are referred to the Kaskaskia Group for the following reasons, to-wit:

Dr. Geo. G. Shumard, who accompanied Marcy's Exploration of the Red River of Louisiana, in 1852, and whose remarks upon the general geology of the country passed over by the exploring expedition were published in 1854 (Expl. Red Riv. Lou. p. 156), thus described the geological features of a portion of Northwestern Arkansas:

"In Washington county we have a fine development of rocks belonging to the carboniferous period, rising sometimes several hundred feet above the water level of Arkansas River. They consist of beds of dark gray and bluish-gray limestone, surmounted by heavy-bedded. coarse and fine grained quartzose sandstone. The ridges of highest elevation run nearly north and south through the center of the country. forming a geological back-bone; the waters from one side flowing eastwardly into White River, and on the other westwardly into Illinois River, both streams being tributaries of the Arkansas.

"Wherever the limestone forms the surface-rock, the soil is of excellent character, and for productiveness is unsurpassed by any in the State; but where the sandstone reaches the surface, the soil becomes too arenaceous, and is of inferior quality for agricultural purposes. The limestone is generally highly charged with fossils, and, in many places, beds of considerable thickness are almost entirely composed of the remains of crinoidea.

"In the lithological and palæontological characters it corresponds very closely to the rocks of the superior division of the carboniferous system of Indiana, Kentucky, Illinois and Missouri. The fossils are usually remarkably well preserved. The following are the most abundant and characteristic species: *Archimedipora archimedes*, *Agassizocrinus dactyliformis*, *Pentremites sulcatus*, *Productus cora*, *P. punctatus*, *P. costatus*, *Terebratula subtilita*, and *T. marcyi*. We have found all these species associated together in Grayson county, Kentucky, near Salem, Indiana, and at Chester and Kaskaskia, Illinois.

"The line of junction between the sandstone and limestone is

well defined, there being an abrupt transition from the one into the other. The sandstone has yielded but few fossils, and these only calamites and ferns."

In the same work, Dr. B. F. Shumard described from the grayish earthy limestone of Washington county, *Cyathocrinus granuliferus*. and identified it with a fossil found at the summit of Muldrow's Hill, in Kentucky.

It is very evident that as early as 1852 both Dr. Geo. G. and Dr. B. F. Shumard were well acquainted with the superior division of the sub-carboniferous rocks in Illinois, Missouri, Indiana, Arkansas and Kentucky, but they did not propose a name by which the division might be known.

In 1856 (Trans. Alb. Inst. vol. 4), Prof. James Hall described new species of fossils from the carboniferous limestones of Indiana and Illinois, and separated the Groups of beds of limestone, shale, etc., constituting the carboniferous formation into seven members, and for the first time used a geographical name for the Group in question. He said:

"This section is compiled from observations made in the Valley of the Mississippi River, from Burlington, Iowa, to near the mouth of the Ohio; and from previous examinations made in Indiana and Illinois. The same formations having been traced southward through Kentucky, Tennessee and Alabama, I believe we have now a definite conception of the members which constitute the great carboniferous limestone formation, which in one or other of its members extends from near the center of Iowa on the northwest, through Illinois and Indiana to the southwest, and south through Missouri, Arkansas, in part, Kentucky, Tennessee and Alabama. (I have in another place acknowledged my obligations to Mr. A. H. Worthen, of Illinois, who aided me in tracing out and determining these Groups.)

"I am satisfied that a more careful study of the fossil remains from these beds will sustain the view I have taken; and we shall hereafter recognize each of these Groups as possessing its own *fauna*, which to a great extent will prove distinct from all the others.

"VII. Coal measures.

"VI. Kaskaskia limestone, or upper *Archimedes* limestone.

"*Localities.*—Kaskaskia and Chester, Ill., St. Marys, Miss., etc.

"V. Gray, brown or ferruginous sandstone, overlying the limestones of Alton and St. Louis.

"*Localities.*—Below St. Genevieve, Missouri; between Prairie du Rocher and Kaskaskia, Illinois.

"IV. St. Louis limestone, concretionary limestone.

"*Localities.*—Highest beds below Keokuk, Iowa; St. Louis, Missouri; St. Genevieve.

"III. Arenaceous bed; second Archimedes, or Warsaw limestone.

"*Localities.*—Warsaw, above Alton, Illinois; Spergen Hill, Bloomington, Indiana.

"Beds of passage; soft shaly or marly bed, with geodes of quartz, chalcedony, etc.

"II. Keokuk limestone, or lower Archimedes limestone.

"*Localities.*—Keokuk, Quincy, Illinois, etc.

"Beds of passage; cherty beds 60 to 100 feet.

"Rapids above Keokuk.

"I. Burlington limestone.

"*Localities.*—Burlington, Iowa; Quincy, Illinois; Hannibal, etc., Missouri."

In 1858 Prof. James Hall (Geo. Sur. of Iowa, vol. 1, pt. 2) said:

"The Kaskaskia limestone, so well developed at Kaskaskia, and thence along the river bottom to Chester, and as far as Fountain Bluff, is unknown up to the present time within the limits of the State of Iowa. I have, nevertheless, felt it my duty to illustrate in some measure its fossil remains, in order to prove its distinctness from the Keokuk limestone, with which it has, heretofore, been identified as the 'Archimedes limestone.' The fossils selected for this purpose are of the same class, and represent the forms, chiefly, of Crinoidea and Brachiopoda, which are most commonly found in these limestones. No species common to the two limestones have been observed by myself; and though probably such do occur, they are certainly not numerous, nor among the prominent forms which everywhere mark the two rocks."

He described from the Kaskaskia limestone at Kaskaskia and Chester, Illinois, *Scaphiocrinus decabrachiatus*, *S. internodius*, *S. scoparius*, *Zeacrinus intermedius*, *Z. maniformis*, *Z. wortheni*, *Agassizocrinus gibbosus*, *A. constrictus*, *Cyathocrinus pentalobus*, *Dichocrinus protuberans*, *Acrocrinus urniformis*, *Pentremites cherokeus*, *P. cerrinus*, *P. godoni*, *P. pyriformis*, *Agelacrinus kaskaskensis*, *Archæocidaris norwoodi*, *Athyris sublamellosa*, *A. subquadrata*, *Retzia vera*, *R. vera var costata*, *Spirifera setigera*, *S spinosa*, *S. increbescens*. Several of these species are mentioned as occurring in Kentucky and other places. *Zeacrinus magnoliæformis*, *Pentremites symmetricus*, *P. obesus* and *P. globosus*, are mentioned as occurring in the same limestone in Tennessee, Kentucky, and elsewhere.

In October, 1860, Prof. G. C. Swallow (Trans. St. Louis Acad. Science, vol. 2) read a paper, entitled "Descriptions of some new Fossils from the Carboniferous and Devonian Rocks of Missouri," in which he described *Terebratula arcuata* and *Natica chesterensis* from the Kaskaskia Limestone in St. Genevieve county, Missouri, and at Chester, Illinois, and *Allorisma antiqua*, which he said was common in the Kaskaskia limestone in Illinois and Missouri.

We have, therefore, in a period of eight years, from 1852 to 1860, a description of the distribution and extent of the Kaskaskia limestone, and the definition and illustration of numerous fossils which characterize it, by Dr. Geo. G. and Dr. B. F. Shumard, Prof. James Hall, and Prof. G. C. Swallow, appearing in such standard scientific publications as the Exploration of the Red River of Louisiana, the Transactions of the Albany Institute, the Geological Survey of Iowa, and the Transactions of the St. Louis Academy of Sciences.

In 1866, the State Geologist of Illinois (Geo. Sur. of Ill., vol. 1) said:

"In the spring of 1853, while acting as Assistant Geologist in the Illinois survey, I was directed by Dr. Norwood, at that time the State Geologist, to go to Randolph county and determine, if possible, the relative position of the St. Louis limestone, and the beds forming the river bluffs at Chester; and it is, perhaps, proper to state that up to that time the former were supposed to overlie the latter beds.

"At Prairie du Rocher, in the northern part of the county, I found the St. Louis limestone *in situ*, forming the entire bluff, and two miles below I saw this limestone passing under a massive brown sandstone, more than a hundred feet in thickness. Six miles below Prairie du Rocher, this sandstone also passed below the surface, and was succeeded by another limestone formation, which was traced continuously to Chester, and from there south along the river bluffs into Jackson county, where it was overlaid by the sandstones that form the base of the coal measures. I returned to New Harmony, Indiana, the headquarters of the survey at that time, and communicated the results to Dr. Norwood, with a copy of my notes and a section, in which I designated the beds at Chester as the Chester limestone. He expressed some doubts as to the correctness of the conclusions to which I had arrived, because they conflicted with the views of most western geologists, especially those of Missouri, and he proposed going over the ground with me, for the purpose of reviewing the section I had made. Accordingly in the autumn of the same year I revisited that region, in company with Dr. Norwood, and we retraced the bluffs from the Big

Muddy River, in Jackson county, to Prairie du Rocher, in Randolph county, confirming to his entire satisfaction the correctness of the section previously made. Holding a subordinate position in the survey, I did not feel at liberty to publish the facts I observed in the prosecution of my labors in the field, and as they were not announced by the Chief of the Survey, who alone had the authority to make known the scientific results attained in the prosecution of the work, these facts remained unknown, except to the members of the Illinois corps.

"On the appearance of the Missouri Report, in 1855, in which all the limestones, containing the screw-shaped fossil known as *Archimedes*, were grouped together under the name of *Archimedes* limestone, and placed below the St. Louis limestone, I informed Prof. Hall, with whom I was then engaged in the Iowa Survey, of the result of the observations I had previously made, in Illinois, and the true sequence of the strata, as determined in the section above named, and he at once proposed that, at the conclusion of our field labors in Iowa for that season, we should go to Randolph county, that he might verify by personal observation the conclusions at which I had arrived. Accordingly, in October of that year, we went together to that county, and for the third time I traced the bluffs, on foot, from Prairie du Rocher to Chester, and for the second time verified the results of my first examination. In the following year (1856), Prof. Hall read a paper before a meeting of the Albany Institute, in which the subdivisions of the sub-carboniferous limestones are given substantially as they subsequently appeared in the Iowa Report. His reasons for substituting the name of *Kaskaskia* for Chester limestone do not appear, and we prefer to retain the name first given to it, when its true position in the series was determined."

It follows from what has been said that the name *Kaskaskia limestone* has by publication ten years' priority over *Chester limestone*, and that while Prof. Worthen was an independent discoverer of the true position of these rocks, that he was nevertheless a year behind Dr. Geo. G. Shumard in determining their position, and twelve years behind him in publishing such determination. Moreover, Dr. Shumard had, at that early time, determined their extent and distribution, not only over a small area in the State of Illinois, but in Missouri, Arkansas, Indiana and Kentucky.

In conclusion, it is evident that by all the rules governing scientific nomenclature, in matters of priority, the name *Chester limestone* or *Chester Group* must be stricken out because it is a synonym for Kaskaskia

limestone; and the name Kaskaskia limestone, or Kaskaskia Group, as I prefer to call it, retained for the upper division of the sub-carboniferous formation.

POTERIOCRINUS WETHERBYI, n. sp. (Plate VIII., fig. 1, natural size; 1*a*, anterior view showing azygos interradials; 1*b*, magnified view of part of the proboscis.)

Column.—The column is composed of alternately thin and thicker joints, and is evidently very long. It is pentagonal at the head, but gradually assumes the cylindrical form below, so that at the distance of three inches below the body the pentagonal form can not be observed. It slightly enlarges as it approaches the junction with the head, probably, not in excess, however, of the angles necessary to create the pentagonal column. The articulating faces of the plates are strongly marked by radiating furrows, which ornament, by their serrated edges, the surface of all weathered columns.

Body.—The length of the body is greater than the diameter. It is nearly obconoidal, or rather, regularly expanding from the column to the second radials. The plates are smooth and slightly convex. The sutures are well defined.

Basal pieces.—There are five pentagonal basal plates, each of which is a little longer than wide. The two longer sides of each join the adjacent basal plates; the two shorter ones form the upper sloping sides, upon which the subradials rest; and the other side articulates with one of the five sides of the pentagonal column.

Subradials.—Three of the subradials are hexagonal, and two heptagonal. The two longest sides of each plate join with the adjacent subradials; the two shortest sides meet the basals below; and the superior sides of the hexagonal plates support the first radials above. The heptagonal plate on the left of the azygos interradius, supports upon its upper truncated side the left anterior first radial, upon its left superior sloping side the second left anterior first radial, and upon its right superior sloping side the first azygos interradial. The other heptagonal plate is situated more directly beneath the azygos interradius. It supports upon its upper slightly truncated side the second azygos interradial; upon its left superior sloping side the first azygos interradial; and upon its right superior sloping side the right anterior first radial.

First radials.—The first radials are pentagonal and wider than long. The upper strongly truncated side of each upon which the second ra-

dials rest is the longest. Two sides of each rest upon the superior sloping sides of the subradials, and the other two join the adjacent first radials, except as to the right anterior first radial which joins one side with the second azygos interradial, and the left anterior radial which rests one side upon the first azygos interradial, and another joins the third azygos interradial, while at the angle of junction it is met by an angle of the second azygos interradial.

Second radials.—The second radials are pentagonal, longer than wide, rounded and constricted in the middle, and support the arms upon their superior sloping sides.

Azygos interradials.—There are three azygos interradials. The first is quadrangular—two sides rest upon the subradials, the left superior side joins the left anterior first radial, and the right superior side supports the second azygos interradial. The second is pentagonal, and rests upon the slightly truncated top of the anterior subradial; its left inferior side joins the first azygos interradial; its right inferior side joins the right anterior first radial, its right superior side supports the right anterior second radial, and the left superior side joins the third azygos interradial. The third is quadrangular, the lower sides are joined by the left anterior first radial, and the second azygos interradial, and the superior sides by the two anterior second radials.

Arms.—There are ten very long, strong, round arms supported upon the superior sloping sides of the second radials. They are composed of wedge-shaped pieces, alternately arranged, so as to bring the thicker ends upon each side of the groove, not upon the outer and inner face of the arm. The first arm pieces have each a length equal to the diameter of the arm, and as they rest upon the superior sloping sides of the second radials they are twice as long upon one side as upon the other. Immediately above the first arm piece, two arm pieces have a length about equal to the diameter of the arm, but at the distance of about three inches from the first arm piece, the diameter is about equal to the length of three pieces. Each arm piece supports upon its thicker end a long slender single-jointed pinnule. These pinnules are alternately arranged on the two sides of the deep longitudinal groove or channel on the inner face of each arm. The thicker ends of the arm plates project, at the upper side, so as to form steps upon the arm, which constitute additional supports for the bases of the pinnules. The first piece in each pinnule is short and spreading at the base—above this each piece is three or four times as long as its diameter.

Proboscis.—The proboscis is long, and from appearances nearly

round and gradually tapering. It is composed of rather large plates, much longer than wide, which are united longitudinally by pectinated edges, that much resemble the sculpturing in the pectinated rhombs of the Cystidea.

Locality.—This species is described from specimens in the collection of Prof. A. G. Wetherby, who discovered them in rocks of the age of the Kaskaskia Group, in Pulaski county, Kentucky.

Eupachycrinus spartarius, n. sp.

[Ety.—*Spartarius*, of or belonging to a broom].

Plate VIII., fig. 2, anterior view, showing azygos interradials, and one arm springing from a second radial, and two arms from a third radial; fig. 2*a*, posterior side showing two arms springing from a second radial.

Column round.

Body.—Body robust, bowl-shaped, deeply sunken for the reception of the column, constricted at the arm bases, and with its strong arms, much resembling in shape the ordinary hickory or oak scrubbing-broom. Plates thick, strong, smooth and slightly convex. Sutures well defined.

Basals.—Basals small and deeply sunken in the depression of the under side. Their shape not determined.

Sub-radials.—Sub-radials large, curving upward upon the outside and into and upward in the concavity of the under side of the body. The two superior sloping sides of each of four sub-radials support first radials, while the one upon the azygos side in addition to joining with two first radials also bears two azygos interradials upon its irregular upper sides.

First radials.—The first radials are pentagonal, and nearly twice as wide as high. The upper strongly truncated side of each, upon which the second radials rest, is the longest; the two inferior sides of each rest upon the superior sloping sides of the sub-radials; and the other two sides join the adjacent first radials, except as to the right and left anterior first radials, which join one side each with an azygos plate. The left anterior one unites a very short side with a sub-radial, and is more irregularly pentagonal than the other first radials.

Second radials.—The second radials are pentagonal, about two thirds as large as the first radials, and a little more than twice as wide as high. The longest side of each articulates with a first radial, the shortest sides unite with the adjacent second radials except as to the

two which join the azygos plates. The posterior second radial bears upon each of its superior sloping sides an arm, while each of the other four second radials bears on one superior sloping side an arm, and upon the other a third radial bearing two arms; thus furnishing to the crinoid fourteen arms.

Third radials.—The four third radial pieces are each pentagonal, and nearly twice as wide as high.

Azygos interradials.—There are three azygos interradials visible upon the outer side, the third one of these is seen as high as the first arm pieces, and thus indicates that it may unite with other plates which terminate in a pointed proboscis within. The first or lower azygos interradial rests an arcuate side upon a sub-radial, joins its left arcuate side with a first and second radial, and its left side wlth the second and third azygos plates. The second azygos plate is very irregularly pentagonal. The lower side rests upon a sub-radial, the left inferior side joins the first azygos plate, the right inferior side joins the first radial, the right superior side joins a second radial, while the left superior or upper side supports the third azygos plate.

Proboscis.—The proboscis is seen projecting like a needle at the upper broken end of the specimen which is illustrated. The azygos interradials cover a convex ridge over the vault, which terminates at the center in a small proboscis.

Arms.—The arms are strong, simple, convex on the outer side, and flattened laterally so as to fit close together. The first arm plate is double the size of the succeeding ones, the next two to four arm plates are wedge shaped, and above these there is a double alternating series of wedge-shaped pieces in each arm. The number of single wedge-shaped pieces, between the first arm plate and the double alternating series, varies in different arms in the same specimen, and probably varies in different specimens. The furrow upon the inner side of each arm is protected by a pinnule springing from every plate, upon each side of the arm; this arrangement, when the arms are folded, fills the interior with a dense mass of pinnules.

This species is readily distinguished from *Eupachycrinus boydi* by the number, position and shape of the azygos interradials, as well as by the form and proportional size of other plates.

Locality.—This species is described from specimens in the collection of Prof. A. G. Wetherby, who discovered them in rocks of the age of the Kaskaskia Group, in Pulaski county, Kentucky.

EUPACHYCRINUS GERMANUS, n. sp. (Plate VIII., fig. 3, anterior view.)

[Ety.—*Germanus*, near a-kin, come of the same stock; from its resemblance to *E. spartarius*.]

Column.—Column round.

Body.—Body bowl-shaped, deeply sunken for the reception of the column, constricted at the arm bases, and much resembling *E. spartarius*, though less robust, plates less convex, and sutures not so well defined.

Basals.—Basals small and deeply sunken in the depression of the under side. Shape not determined.

Subradials.—Subradials large, curving upward upon the outside and into and upward in the concavity of the under side of the body, where each of them has a mesial notch or depression. The superior sloping sides of four subradials support first radials, but the left anterior subradial also supports the first azygos plate. The anterior subradial supports upon its right superior side a first radial, upon its left the first azygos plate, and upon its upper slightly truncated edge the second azygos plate.

First radials.—The first radials are pentagonal, and a little wider than high. The upper strongly truncated side is the longest. The two inferior sides of each rest between the superior sloping sides of the subradials below, except as to the left anterior first radial, which is supported upon its right inferior side by the first azygos interradial. The other two sides join the adjacent first radials, except as to the two anterior plates. The left anterior one is almost if not quite quadrangular, for the third azygos plate barely touches it.

Second radials.—The second radials are pentagonal, not quite as large as the first radials, and nearly twice as wide as high. The longest side of each articulates with a first radial, the shortest sides unite with the adjacent second radials except as to the two which join the azygos plates. The posterior second radial bears upon each of its superior sloping sides an arm, while each of the other four second radials bears on one side an arm, and upon the other a third radial bearing two arms; thus furnishing to the crinoid fourteen arms.

Third radials.—The four third radial pieces are each pentagonal, and nearly as high as wide.

Azygos interradials.—The first or lower azygos plate is pentagonal; the two inferior sides resting upon sub-radials, the left superior side supporting a first radial, the right superior side the second azygos plate, and the upper side the third azygos plate. The second plate is hexagonal. It rests upon the anterior sub-radial, the inferior sloping sides are supported between the first azygos plate and a first radial. the superior sloping sides between a second radial and the third azygos

plate, and the upper side supports the fourth azygos plate. The third azygos plate is supported below upon the first azygos plate, the right inferior side joins the second azygos, the right superior the fourth azygos, the top the fifth azygos, the left side a second radial, and it corners with a first radial below. The fourth azygos plate reaches upon one side the right anterior second radial, otherwise it is joined to azygos plates. The fifth azygos is bounded by azygos plates. The azygos plates cover a convex ridge to the center of the vault, and terminate in a small needle-like proboscis.

Arms.—The arms are strong, simple, slightly convex upon the outer side, and flattened latterally so as to fit close together. The first arm plate is double the size of succeeding ones, this is followed by from two to four wedge-shaped pieces in each arm, and above these there is a double series of alternating wedge-shaped pieces. The furrow upon the inner side of each arm is protected by a pinnule springing from every plate upon each side of the arm.

This species is distinguished from *E. spartarius*, which it most resembles, chiefly by the number, form, and arrangement of the azygos interradials, and by the shape of the left anterior first radial, though it differs in minor details in nearly all parts of the body and arms.

Locality.—This species is described from specimens in the collection of Prof. A. G. Wetherby, who discovered them in rocks of the age of the Kaskaskia Group, in Pulaski county, Kentucky.

LEPIDESTHES FORMOSUS, n. sp. (Plate VIII., fig. 4, magnified two diameters.

[Ety.—*Formosus*, beautiful.]

The general form of the body, judging from a single compressed specimen, is subspheroidal or truncato-elliptical. Surface of the plates smooth.

Ambulacral areas.—The ambulacral areas are somewhat lance-elliptical in shape, and apparently sufficiently convex to preserve the circular shape of the body. These areas are occupied by numerous rhomboidal and irregularly hexagonal pieces, arranged in curved lines crossing each other in quincuncial order, and imbricating downward. The specimen shows eight plates, in each curved row, below the first five, from the ocular pieces. Ten rows of 8 plates each may be counted in one ambulacral area of the specimen; the difference in width of the area being compensated by a greater exposure of the surface of the plates as we approach the middle; some of the rows have nine plates, and it may be that a better specimen will show more pieces in the central part of

the area. The edges of all the plates are beveled so as to permit the imbricated arrangement without producing a very rough outer surface. There are two ambulacral pores in the central part of each piece, arranged transversely.

Interambulacral areas.—The interambulacral areas are covered by five rows of plates, which imbricate upward and outward. This arrangement allows the plates in the middle row to project their under beveled edges upon the plates on each side, while the plates in the outer rows project their beveled edges upon the inter-ambulacral plates.

Ovarian plates.—One Ovarian plate shows two genital pores, and another one shows three, and one apparently shows four, but the depressed condition of the specimen will not permit of too much certainty respecting these pores. The ocular pieces, or pieces between the Ovarian plates, are a little smaller than the Ovarians, and one of them shows two pores, or at least what appears under an ordinary magnifier to represent two pores.

The apical disc is composed of several plates, but the condition of our specimen will not permit us to determine with certainty their exact arrangement.

Locality.—This species is described from a single specimen in the collection of Prof. A. G. Wetherby, who discovered it in rocks of the age of the Kaskaskia Group, in Pulaski County, Kentucky.

CATALOGUE OF THE FLOWERING PLANTS, FERNS AND FUNGI GROWING IN THE VICINITY OF CINCINNATI.

By Joseph F. James.

The following catalogue has been compiled from personal observation, and from the catalogues of Messrs. Lea and Clark. Their lists contain the names of some species which I have not identified as found in this locality. In such cases their respective names are given in brackets. I am especially indebted to Mr. T. W. Spurlock for valuable information and specimens, which, but for his indefatigable work in collecting, I should perhaps not have seen. Thanks are also due to my brother, Mr. Davis L. James, to Dr. J. H. Hunt, Dr. R. M. Byrnes, Mr. F. W. Langdon, Mr. C. G. Lloyd, Mr. J. L. Taylor and others, for specimens and information.

Such changes have been made in the nomenclature and arrangement

of the orders as have been made necessary by recent investigations. As far as the order *Caprifoliaceæ*, the arrangement in Watson's Bibliographical Index to North American Botany has been followed. After that the arrangement in Gray's Manual. Some genera have been merged in old ones, and some species of one genus transferred to another. Whenever such has been the case in late years, synonyms are given.

The list of fungi has been copied bodily from the excellent catalogue of Mr. Lea, published in 1849. As this is now out of print, and almost impossible to procure, I have thought that a reprint of this part of his work would be a benefit to such workers as may be inclined to take hold of the subject. A very few have been added as found by my brother, and mention is made of such species of the list as he has identified. Mr. Lea is almost the only one who has collected the lower *Cryptogamia* in this neighborhood extensively, and his list is valuable not only as an index of what we may expect to find here, but also for the valuable notes on the locations of the species, as well as descriptions of new ones. The name of Rev. M. J. Berkeley, to whom the arrangement of this portion of Mr. Lea's collection was intrusted, is sufficient guarantee of its accuracy, and the corrections in nomenclature and orthography, which have kindly been made by Prof. Chas. H. Peck, of Albany, New York, make this portion of the catalogue as correct as the present state of knowledge permits.

RANUNCULACEÆ.

CLEMATIS, L.

1 Viorna, L. Leather Flower.
2 Virginiana, L. Common Virgin's Bower.

ANEMONE, L.

3 Virginiana, L. Virginian Anemone.
4 dichotoma, L.
5 acutiloba, Lawson. Sharp Lobed Hepatica (Hepatica acutiloba, D C).
6 Hepatica, L. Round Lobed Hepatica (Hepatica triloba, Chaix, (Clark's Cat).

THALICTRUM, Tourn.

7 anemonoides, Michx. Rue-Anemone.
8 dioicum, L. Early Meadow Rue.
9 purpurascens, L. Purplish Meadow Rue.
10 Cornuti, L. Tall Meadow Rue (Mr. T. W. Spurlock).

TRAUTVETTERIA, Fischer and Meyer.

11 palmata, Fischer and Meyer. False Bugbane (Lea's Cat.)

RANUNCULUS, L.

12 aquatilis, L. Common White Water Crowfoot (Clark's Cat.)
13 Flammula L. Smaller Spearwort (Clark's Cat.)
14 abortivus, L. Small flowered Crowfoot, var. micranthus, Gray.
15 sceleratus, L. Cursed Crowfoot.
16 recurvatus, Poir. Hooked Crowfoot.
17 repens, L. Creeping Crowfoot.
18 acris, L. Tall C., or Buttercups.

ISOPYRUM, L.

19 biternatum, Torr and Gray.

CALTHA, L.

20 palustris, L. Marsh Marigold (Mr. T. W. Spurlock).

AQUILEGIA, Tourn.

21 Canadensis, L. Wild Columbine.

DELPHINIUM, Tourn.

22 tricorne, Michx. Dwarf Larkspur.
23 consolida, L. Field Larkspur.

HYDRASTIS, L.

24 Canadensis, L. Orange Root.

ACTÆA, L.

25 spicata, L., var. rubra, Michx, Red Baneberry (Clark's Cat.)
26 alba, Bigel. White Baneberry.

CIMICIFUGA, L.

27 racemosa, Nutt. Black Snakeroot.

MAGNOLIACEÆ.

LIRIODENDRON, L.

28 Tulipifera, L. Tulip tree.

ANONACEÆ.

ASIMINA, Adams.

29 triloba, Dunal. Common Papaw.

MENISPERMACEÆ.

MENISPERMUM, L.

30 Canadense, L. Canadian Moonseed.

BERBERIDACEÆ.

CAULOPHYLLUM, Michx.

31 thalictroides, Michx. Blue Cohosh. Pappoose Root.

JEFFERSONIA, Barton.

32 diphylla, Pers. Twin-leaf.

PODOPHYLLUM, L.

33 peltatum, L. May Apple. Mandrake.

NYMPHÆACEÆ.

NELUMBIUM, Juss.

34 luteum, Willd. Yellow Nelumbo. Water chinquepin. (Clark's Cat.)

Probably not found here now. Even in Clark's Cat. it is given as probably extinct.

NUPHAR, Smith.

35 advena, Ait. Common Yellow Pond Lily.

PAPAVERACEÆ.

ARGEMONE, L.

36 Mexicana, L. Mexican Poppy. (Mr. F. W. Langdon.)

STYLOPHORUM, Nutt.

37 diphyllum, Nutt. Celandine Poppy.

SANGUINARIA, Dill.

38 Canadensis, L. Blood-root.

FUMARIACEÆ.

DICLYTRA, Bork. (Dicentra.)

39 cucullaria, DC. Dutchman's Breeches.
40 Canadensis, DC. Squirrel Corn.

CORYDALIS, Vent.

41 flavula, Raf.
42 aurea, Willd. Golden Corydalis. (Clark's Cat).

CRUCIFERÆ.

NASTURTIUM, R. Br.

43 officinale, R. Br. True Water Cress.
44 sessilifolium, Nutt. (Valley Junction.)
45 palustre, DC. Marsh Cress.
46 lacustre, Gray. Lake Cress. (Lea's Cat).
47 Armoracia, Fries. Horseradish.

DENTARIA, L.

48 diphylla, L. Two-leaved Toothwort. (Mr. C. G. Lloyd.)
49 laciniata, Muhl. Cut-leaved Toothwort.

CARDAMINE, L.

50 rhomboidea, DC. Spring Cress.
51 purpurea, Cham & Schlecht. Purple Cress.
52 rotundifolia, Michx. Mountain Water Cress. (Clark's Cat).

ARABIS, L.

53 Ludoviciana, Meyer.
54 dentata, Torr. & Gray.
55 hirsuta, Scop.
56 lævigata, DC.
57 Canadensis, L. Sickle-pod.
58 perfoliata, Lam. Tower Mustard. (Mr T. W. Spurlock).

THELYPODIUM.

59 pinnatifidum, Watson. (Arabis hesperidoides, Gray).

Barbarea, R. Br.

60 vulgaris, R. Br. Yellow Rocket.

Erysimum, L.

61 cheiranthoides, L. Worm-seed Mustard.

Sisymbrium, L.

62 officinale, Scop. Hedge Mustard.
63 canescens, Nutt. Tansy Mustard.

Brassica, Tourn.

64 nigra, Koch. Black Mustard.

Draba, L.

65 verna, L. Whitlow Grass. (Clark's Cat.)

Camelina, Crantz.

66 sativa, Crantz. False Flax. (Lea's Cat.)

Capsella, Vent.

67 Bursa-pastoris, Mœnch. Shepherd's Purse.

Lepidium, L.

68 Virginicum, L. Wild Peppergrass.
69 campestre, R. Br. (Clark's Cat.)

CAPPARIDACEÆ.

Polanisia, Raf.

70 graveolens, Raf.

VIOLACEÆ.

Ionidium.

71 concolor, Benth & Hook. Green Violet.
(Solea concolor, Ging.)

Viola, L.

72 cucullata, Ait. Common Blue Violet, var. palmata, Gray. Hand-leaf Violet.
73 pedata, L. Bird-foot Violet. (Clark's Cat.)
74 striata, Ait. Pale Violet.
75 Canadensis, L. Canada Violet.
76 pubescens, Ait. Downy Violet.
77 tri-color, L. Pansey, Heart's Ease. (Clark's Cat.)
var. Arvensis, Gray.

POLYGALACEÆ.

Polygala, Tourn.

78 Senega, L. Seneca Snakeroot. (Mr. C. G. Lloyd.)

CARYOPHYLLACEÆ.

Saponaria, L.

79 officinalis, L. Soapwort. Bouncing Bet.
80 vaccaria, L. Cow Herb. (Dr. O. D. Norton). (Vaccaria vulgaris, Host.)

Silene, L.

81 stellata, Ait. Starry Campion.
82 nivea, DC. (T. W. Spurlock. Clark's Cat.)
83 Pennsylvanica, Michx. Wild Pink. (Clark's Cat.)
84 Virginica, L. Fire Pink. Catchfly.
85 regia, Sims. Royal Catchfly. (Clark's Cat.)
86 antirrhina, L. Sleepy Catchfly.

Lychnis, Tourn.

87 Githago, Lam. Corn Cockle.

Arenaria, L.

88 serpyllifolia, L. (Thyme-leaved Sandwort.)

Stellaria, L.

89 media, Smith. Common Chickweed.
90 pubera, Michx. Great Chickweed.
91 longifolia, Goldie. Long-leaved Stitchwort. (Lea's Cat.)

Cerastium, L.

92 vulgatum, L. Mouse-ear Chickweed.
93 viscosum, L. Larger Mouse-ear Chickweed. (Lea's Cat.)
94 nutans, Raf.
95 arvense, L. Field Chickweed.

PARONYCHIEÆ.

Anychia, Michx.

96 dichotoma, Michx. Forked Chickweed.

PORTULACACEÆ.

Portulaca, Tourn.

97 oleracea, L. Common Purslane.

Claytonia, L.

98 Virginica, L. Spring Beauty.
99 Caroliniana, Michx., var. sessilifolia, Torr. (Clark's Cat. as C. lanceolata.)

HYPERICACEÆ.

Hypericum, L.

100 prolificum, L. Shrubby St. John's wort.

101 sphærocarpon, Michx. (Mr. T. W. Spurlock).
102 perforatum, L. Common St. John's wort.
103 corymbosum, Muhl.
104 mutilum, L.
105 Canadense, L. (Clark's Cat.)

MALVACEÆ.

MALVA, L.

106 rotundifolia, L. Common Mallow.

NAPÆA, Clayt.

107 dioica, L. Glade Mallow. (Mr. T. W. Spurlock).

SIDA, L.

108 spinosa, L.

ABUTILON, Tourn.

109 Avicennæ, Gærtn. Velvet Leaf.

HIBISCUS, L.

110 militaris, Cav. Halberd Leaved Rose Mallow. (Clark's Cat.)

TILIACEÆ.

TILIA, L.

111 Americana, L. Basswood.

LINACEÆ.

LINUM, L.

112 Virginianum, L. (Clark's Cat.)
113 usitatissimum, L. Common Flax.

GERANIACEÆ.

GERANIUM, L.

114 maculatum, L. Wild Cranesbill.
115 Carolinianum, L. Carolina Cranesbill.

FLŒRKEA, Willd.

116 proserpinacoides, Willd. False Mermaid. (Mr. T. W. Spurlock.)

IMPATIENS, L.

117 pallida, Nutt. Pale Touch-me-not.
118 fulva, Nutt. Spotted Touch-me-not.

OXALIS, L.

119 violacea, L. Violet Wood sorrel.
120 corniculata, L., var. stricta, Sav. Yellow Wood sorrel.

RUTACEÆ.

PTELEA, L.

121 trifoliata, L. Shrubby Trefoil. Hop tree.

SIMARUBACEÆ.

AILANTHUS, Desf.

122 glandulosus, Desf. Tree of Heaven.

ILICINEÆ.

ILEX, L.

123 verticillata, Gray. Block Alder. Winterberry (Clark's Cat.)

CELASTRACEÆ.

CELASTRUS, L.

124 scandens, L. Waxwork, Climbing Bitter sweet.

EUONYMUS, Tourn.

125 atropurpureus, Jacq. Burning bush. Waahoo.

RHAMNACÆ.

RHAMNUS, Tourn.

126 lanceolata, Pursh. Buckthorn.

CEANOTHUS, L.

127 Americanus, L. New Jersey Tea (Mr. T. W. Spurlock).

VITACEÆ.

VITIS, Tourn.

128 aestivalis, Michx. Summer grape. (Clarke's Cat.)
129 cordifolia, Lam. Winter or Frost Grape.

AMPELOPSIS, Michx.

130 quinquefolia, Michx. Virginian Creeper.

SAPINDACEÆ.

STAPHYLEA, L.

131 trifolia, L. American Bladdernut.

ÆSCULUS, L.

132 glabra, Willd. Fetid or Ohio Buckeye.
133 flava, Ait. Sweet Buckeye. (Lea's Cat.)

ACER, Tourn.

134 saccharinum, Wang. Sugar or Rock Maple, var. nigrum, Gray. Black Sugar Maple.

135 dasycarpum, Ehrh. White or Silver Maple.
136 rubrum, L. Red or Swamp Maple.

Negundo, Mœnch.

137 aceroides, Mœnch. Ash-leaved Maple. Box-Elder.

ANACARDIACEÆ.

Rhus, L.

138 typhina, L. Staghorn sumach (Clark's Cat.)
139 glabra. Smooth Sumach.
140 copallina, L. Dwarf Sumach.
141 venenata, DC. Poison Sumach, or (R. vernix, L., in Clark's Cat.) Dogwood.
142 Toxicodendron, L. Poison Ivy. Poison Oak, var. radicans, Torrey.

LEGUMINOSÆ.

Trifolium, L.

143 pratense, L. Red Clover.
144 reflexum, L. Buffalo Clover (Clark's Cat.)
145 stoloniferum, Muhl. Running Buffalo, C.
146 repens, L. White Clover.

Melilotus, Tourn.

147 officinalis, Willd. Yellow Melilot.
148 alba, Lam. White Melilot.

Medicago, L.

149 lupulina, L. Black Medick, Nonesuch.

Psoralea, L.

150 Onobrychis, Nutt.

Robinia, L.

151 Pseudacacia, L. Common Locust or False Acacia.

Astragalus, L.

152 Canadensis, L. Canadian Milk Vetch.
153 Cooperi, Gray (Lea's Cat. as Phaca neglecta, Torr. & Gr.)

Desmodium, DC.

154 nudiflorum, DC.
155 acuminatum, DC.
156 pauciflorum, DC. (Clark's Cat.)
157 rotundifolium, DC. (Clark's Cat.)
158 canescens, DC.
159 cuspidatum, Torr. & Gray. (Clark's Cat.)
160 viridiflorum, Beck. (Lea's Cat.)
161 Dillenii, Darlingt. (Lea's Cat.)
162 paniculatum, DC.
163 Canadense, DC. (Lea's Cat.)

Lespedeza, Mich.

164 repens, Barton. Creeping Bush Clover.
165 procumbens, Michx. (Lea's Cat.)
166 violacea, Pers.
167 hirta, Ell. (Clark's Cat.)
168 capitata, Michx. (Clark's Cat.)

Lathyrus, L.

169 venosus, Muhl. Vetchling. (Clark's Cat.)

Apios, Boerhaave

170 tuberosa, Mœnch. Groundnut Wild Bean.

Phaseolus, L.

171 diversifolius, Pers. Kidney Bean.

Amphicarpæa, Ell.

172 monoica, Ell. Hog Peanut.

Baptisia, Vent.

173 australis, R. Br. Blue False Indigo.
174 leucantha, Torr. and Gr. (Clark's Cat.)

Cercis, L.

175 Canadensis, L. Red bud.

Cassia, L.

176 Marylandica, L. Wild Senna.
177 obtusifolia, L. (Mr. T. W. Spurlock.)
178 Chamæcrista, L. Partridge Pea.

Gymnocladus, Lam.

179 Canadensis, Lam. Kentucky Coffee Tree.

Gleditschia, L.

180 triacanthos, L. Three thorned Acacia or Honey Locust.

ROSACEÆ

Prunus, Tourn.

181 Americana, Marshall. Wild, Yellow or Red Plum.

182 serotina, Ehrh. Wild Black Cherry.

NEILLIA, Don.

183 opulifolia, Benth & Hook. Nine-bark. (Spiræa opulifolia, L.)

SPIRÆA, L.

184 lobata, Jacq. Queen of the Prairie. (Clark's Cat.)

185 aruncus, L. Goat's Beard. (Clark's Cat.) (Mr. J. L. Taylor).

GILLENIA, Mœnch.

186 stipulacea, Nutt. American Ipecac.

AGRIMONIA, Tourn.

187 Eupatoria, L. Common Agrmony.

188 parviflora, Ait. (Lea's Cat.)

GEUM, L.

189 album, Gmelin. White avens.

190 Virginianum, L.

191 vernum, Torr. and Gray.

POTENTILLA, L.

192 Norvegica, L.

193 Canadensis, L. Common Cinque-foil, or Five-Finger, var. simplex, Torr. & Gray.

FRAGARIA, Tourn.

194 Virginiana, Ehrh. Wild Strawberry. (Clark's Cat.)

195 vesca L.

RUBUS, Tourn.

196 strigosus, Michx. Wild Red Raspberry.

197 occidentalis, L. Black Raspberry.

198 villosus, Ait. Common Blackberry.

199 Canadensis, L. Dewberry.

ROSA, Tourn.

200 setigera, Michx. Climbing or Prairie Rose.

201 Carolina, L. Swamp Rose. (Clark's Cat.)

202 lucida, Ehrh. Dwarf Wild Rose.

203 blanda, Ait. Early Wild Rose. (Clark's Cat.)

204 rubiginosa, L. Sweet Briar. (Mr. J. L. Taylor).

CRATÆGUS, L.

205 coccinea, L. Scarlet Fruited Thorn.

206 tomentosa, L. Black or Pear Thorn.
var. pyrifolia, Gray.
var. punctata, Gray.

207 Crus-galli, L. Cockspur Thorn.

208 flava, Ait. Summer Haw. (Clark's Cat).

PIRUS, L. (Pyrus).

209 coronaria, L. American Crab Apple.

AMELANCHIER, Medic.

210 Canadensis, Torr. & Gray. Shad Bush, Service Berry.

SAXIFRAGACEÆ.

RIBES, L.

211 Cynosbati, L. Gooseberry.

212 floridum, L'Her. Wild Black Currant. (Lea's Cat.)

HYDRANGEA, Gronov.

213 arborescens, L. Wild Hydrangea.

SAXIFRAGA, L.

214 Virginiensis, Michx. Early Saxifrage. (Miss Chidlaw).

HEUCHERA, L.

215 Americana, L. Common Alum Root.

MITELLA, Tourn.

216 diphylla, L. Mitrewort. Bishop's Cap. (Fort Ancient, Mr. D. L. James. Clark's Cat).

CRASSULACEÆ.

PENTHORUM, Gronov.

217 sedoides, L. Ditch Stone Crop.

SEDUM, Tourn.

218 ternatum, Michx. Stone Crop.

HAMAMELACEÆ.

HAMAMELIS, L.

219 Virginica, L. Witch Hazel.

HALORAGEÆ.

MYRIOPHYLLUM, Vaill. Water Milfoil.

220 spicatum, L. (Clark's Cat.)

221 verticillatum, L. (Clark's Cat.)

222 scabratum, Michx. Clark's Cat.)
223 ambiguum, Nutt. (Clark's Cat.)

MELASTOMACEÆ.

RHEXIA, L.

224 Virginica, L. Deer Grass. Meadow Beauty. Clark's Cat.)

LYTHRACEÆ.

AMMANNIA, Houston.

225 humilis, Michx.
226 latifolia, Linn. (Lea's Cat.)

LYTHRUM, L.

227 Hyssopifolia, L. Loosestrife. (Clark's Cat.)
228 alatum, Pursh.

ONAGRACEÆ.

CIRCÆA, Tourn.

229 Lutetiana, L. Enchanter's Nightshade.

GAURA, L.

230 biennis, L.

EPILOBIUM, L.

231 coloratum, Muhl. Willowherb.

ŒNOTHERA, L.

232 biennis L. Common Evening Primrose.

LUDWIGIA, L.

233 alternifolia, L. Seed-box.
234 palustris, Ell. Water Purslane.

PASSIFLORACEÆ.

PASSIFLORA, L.

235 lutea, L. Yellow Passion Flower.

CUCURBITACEÆ.

SICYOS, L.

236 angulatus, L. One-seeded Star Cucumber.

ECHINOCYSTIS, Torr. & Gray.

237 lobata, Torr. & Gray. Wild Balsam Apple.

CACTACEÆ.

OPUNTIA, Tourn.

238 vulgaris, Haworth. Prickley Pear. Indian Fig.
Found by Dr. J. H. Hunt, at Valley Junction, Ohio, where it has apparently become naturalized.

FICOIDEÆ.

MOLLUGO, L.

239 verticillata, L. Carpetweed.

UMBELLIFERÆ.

SANICULA, Tourn.

240 Canadensis, L. Sanicle.
241 Marylandica, L.

DAUCUS, Tourn.

242 Carota, L. Common Carrot.

CAUCALIS, L.

243 anthriscus, Huds. (C. G. Lloyd, Newport, Ky.)

HERACLEUM, L.

244 lanatum, Michx. Cow Parsnip. (Lea's Cat.

PASTINACA, Tourn.

245 sativa, L. Common Parsnip.

ARCHEMORA, DC.

246 rigida, DC. Cowbane. (Clark's Cat.)

ARCHANGELICA, Hoffm.

247 hirsuta, Torr. & Gray. (Clark's Cat.)

THASPIUM, Nutt. Meadow Parsnip.

248 barbinode, Nutt.
249 aureum, Nutt.
250 trifoliatum, Gray.

PIMPINELLA, (Zizia, DC.)

251 integerrima, Benth & Hook.

CICUTA, L.

252 maculata, L. Spotted Cowbane. (Mr. T. W. Spurlock.)
253 bulbifera, L. (Clark's Cat.)

SIUM, L.

254 latifolium, L. (Clark's Cat.)

CRYPTOTÆNIA, DC.

255 Canadensis, DC. Honewort.

CHÆROPHYLLUM, L.

256 procumbers, Crantz. Chervil.

OSMORRHIZA, Raf.

257 longistylis, DC. Smoother Sweet Cicely.
258 brevistylis, DC. Hairy Sweet Cicely.

CONIUM, L.

259 maculatum. L. Poison Hemlock. (Clark's Cat.)

ERIGENIA, Nutt.

260 bulbosa, Nutt. Harbinger-of-spring.

ARALIACEÆ.

ARALIA, Tourn.

261 spinosa, L. Angelica Tree. Hercules' Club.
262 racemosa, L. Spikenard.
263 quinquefolia, Dec. & Planch. Ginseng.

CORNACEÆ.

CORNUS, Tourn.

264 florida, L. Flowering Dogwood.
265 circinata, L'Her. Round Leaved Dogwood. (Clark's Cat).
266 sericea, L. Silky Cornel. Kinnikinnik.
267 paniculata, L'Her. Panicled Cornel.

NYSSA, L.

268 multiflora, Wang. Tupelo. Black or Sour Gum. Pepperidge.

CAPRIFOLIACEÆ.

SYMPHORICARPUS, Dill.

269 vulgaris, Michx. Indian Currant. Coral Berry. (Mr. D. L. James.)

LONICERA, L.

270 flava, Sims. Yellow Honey Suckle.

TRIOSTEUM, L.

271 perfoliatum, L. Fever-wort. Horse Gentian. (Clark's Cat.)
272 angustifolium, L. (Mr. T. W. Spurlock, Mr. C. G. Lloyd.)

SAMBUCUS, Tourn.

273 Canadensis, L. Common Elder.

VIBURNUM, L.

274 prunifolium, L. Black Haw.
275 acerifolium, L. Maple Leaved Arrow-wood. Dockmackie.
276 Opulus, L. Cranberry tree.

RUBIACEÆ.

GALIUM, L.

277 Aparine, L. Cleavers. Goose-grass.
278 trifidum, L. Small Bedstraw.
var. tinctorium, Gray. (Lea's Cat.)
var. latifolium, Gray. (Lea's Cat.)
279 triflorum, Michx. Sweet Scented Bedstraw.
280 circæzans, Michx. Wild Liquorice.
281 latifolium, Michx. (Clark's Cat.)

CEPHALANTHUS, L.

282 occidentalis, L. Buttonbush.

MITCHELLA, L.

283 repens, L. Partridge-berry.

OLDENLANDIA, Plumier, L.

284 glomerata, Michx. (Lea's Cat.)

HOUSTONIA, L.

285 purpurea, L.
var. longifolia, Gray. (Clark's Cat).
var. ciliolata, Gray. (Lea's Cat.)
286 cærulea, L. Bluets.

VALERIANACEÆ.

VALERIANA, Tourn.

287 pauciflora, Michx.

FEDIA, Gærtn.

288 radiata, Michx. Corn Salad.
289 patellaria, Sulliv. (Lea's Cat.)

DIPSACEÆ.

DIPSACUS, Tourn.

290 sylvestris, Mill. Wild Teasel.

COMPOSITÆ.

VERNONIA, Schreb.

291 fasciculata, Michx. Ironweed.

ELEPHANTOPUS, L.

292 Carolinianus, Willd. Elephant's Foot. (Mr. J. L. Taylor.)

EUPATORIUM, Tourn.

293 purpureum, L. Joe Pye Weed. Trumpet Weed.
294 sessilifolium, L. Upland Boneset. (Lea's Cat.)
295 perfoliatum, L. Boneset.
296 ageratoides, L. White Snake-root.

CONOCLINIUM, DC.

297 cœlestinum, DC. Mist Flower.

ASTER, L. Starwort.
298 corymbosus, Ait.
299 macrophyllus, L. (Mr. T. W. Spurlock.)
300 patens, L., var. phlogifolius, Gray.
301 Shortii, Booth.
302 undulatus, L. (Clark's Cat.)
303 cordifolius, L.
304 sagittifolius, Willd.
305 ericoides, L.
306 multiflorus, Ait.
307 Tradescanti, L., var. fragilis, Gray.
308 miser, L., Ait.
309 simplex, Willd. (Lea's Cat.)
310 Æstivus, Ait.
311 puniceus, L.
312 prenanthoides, L.
313 Novæ-Angliæ, L.

ERIGERON, L.
314 Canadense, L. Horse-weed, Butter-weed.
315 bellidifolium, Muhl. Robin's Plantain.
316 Philadelphicum, L. Common Fleabane.
317 annuum, Pers. Daisy Fleabane. Sweet Scabious.
318 strigosum, Muhl. Daisy Fleabane.

SOLIDAGO, L. Golden rod.
319 latifolia, L.
320 cæsia, L.
321 speciosa, Nutt. (Lea's Cat.)
322 Riddellii, Frank. (Clark's Cat.)
323 patula, Muhl. (Mr. T. W. Spurlock.)
324 ulmifolia, Muhl.
325 nemoralis, Ait. (Lea's Cat.)
326 Canadensis, L.
327 gigantea, Ait. (Clark's Cat.)
328 lanceolata, L.

INULA, L.
329 Helenium, L. Common Elecampane. (Mr. T. W. Spurlock.)

PLUCHEA, Cass.
330 foetida, DC. Fetid Marsh Flea-bane.

POLYMNIA, L.
331 Canadensis, L. Leafcup.
332 Uvedalia, L.

SILPHIUM, L.
333 terebinthinaceum, L. Prairie Dock.
334 trifoliatum, L.
335 perfoliatum, L. Cup Plant.

AMBROSIA, Tourn.
336 trifida, L. Great Ragweed.
337 Artemisiæfolia, L. Roman wormwood Hogweed.

XANTHIUM, Tourn.
338 strumarium, L. Common Cocklebur var echinatum. Gray.
339 spinosum, L. Spiny Clotbur.

ECLIPTA, L.
340 procumbens, Michx.

HELIOPSIS, Pers.
341 lævis, Pers., var. scabra, Gray. Ox-eye.

RUDBECKIA, L.
342 laciniata, L. Cone Flower.
343 triloba, L.
344 speciosa, Wenderoth. (Lea's Cat.)
345 fulgida, Ait. (Clark's Cat.)
346 hirta, L.

LEPACHYS, Raf.
347 pinnata, Torr. & Gray.

HELIANTHUS, L.
348 annuus, L. Common Sunflower.
349 mollis, Lam. (Clark's Cat.)
350 microcephalus, Torr. & Gray. (Lea's Cat.)
351 giganteus, L. (Clark's Cat.)
352 grosse-serratus, Martens. (Lea's Cat.)
353 strumosus, L. (Clark's Cat.)
354 divaricatus, L. (Lea's Cat.)
355 hirsutus, Raf.
356 decapetalus, L., var. frondosus, Gray. (Clark's Cat.)
357 doronicoides, Lam.
358 tuberosus, L. Jerusalem Artichoke. (Clark's Cat.)

ACTINOMERIS, Nutt.
359 squarrosa, Nutt.
360 helianthoides, Nutt. (Clark's Cat.)

COREOPSIS, L., Tickseed.
361 auriculata, L.
362 tripteris, L. Tall Coreopsis.

BIDENS, L.
363 frondosa, L. Common Beggarticks.

364 connata, Muhl. Swamp Beggarticks.•
365 chrysanthemoides, Michx. Larger Bur-Marigold.
366 bipinnata, L. Spanish Needles.

DYSODIA, Cav.
367 chrysanthemoides, Lag. Fetid Marigold.

HELENIUM, L.
368 autumnale, L. Sneezeweed.

MARUTA, Cass.
369 cotula, DC. Common Mayweed.

ACHILLEA, L.
370 millefolium, L. Common Yarrow or Milfoil.

LEUCANTHEMUM, Tourn.
371 vulgare, Lam. Ox-eye or White Daisy.

TANACETUM, L.
372 vulgare, L. Common Tansy.

ARTEMISIA, L.
373 vulgaris, L. Common Mugwort. (Mr. C G. Lloyd.)
374 biennis, L. Biennial Wormwood.
375 abrotanum, L. Southern wood.

GNAPHALIUM, L.
376 polycephalum, Michx. Common Everlasting.
377 uliginosum, L. Low Cudweed.
378 purpureum, L. Purplish Cudweed. (Mr. J. L. Taylor.)

ANTENNARIA, Gærtn.
379 plantaginifolia, Hook. Plantain leaved Everlasting.

ERECHTHITES, Raf.
380 hieracifolia, Raf. Fireweed.

CACALIA, L.
381 suaveolens, L. (Clark's Cat.)
382 reniformis, Muhl. Great Indian Plantain.
383 atriplicifolia, L. Pale Indian Plantain.

SENECIO, L.
384 aureus, L. Golden Ragwort. Squaw weed, var. obovatus, Gray.

CNICUS, Vaill. (Cirsium, Tourn).
385 lanceolatus, Hoffm. Common Thistle.
386 discolor, Spreng. (Clark's Cat.)
387 altissimus, Willd.
388 Virginianus, Pursh.
389 muticus, Pursh. Swamp Thistle.
390 arvensis, Hoffm. Canada Thistle.

ONOPORDON, Vaill.
391 acanthium, L. Cotton or Scotch Thistle.

LAPPA, Tourn.
392 officinalis, Allioni. Burdock.

CYNTHIA, Don.
393 Virginica. Don.

HIERACIUM, Tourn.
394 scabrum, Michx. Rough Hawkweed.
395 Gronovii, L. Hairy Hawkweel. (Clark's Cat.)
396 paniculatum, L. Panicled Hawkweed. (Clark's Cat.)

NABALUS, Cass.
397 albus, Hook. White Lettuce. Rattlesnake root.
398 altissimus, Hook. Tall White Lettuce.
399 crepidineus, DC.

TARAXACUM, Haller.
400 Dens-leonis, Desf. Dandelion.

LACTUCA, Tourn.
401 Canadensis, L. Wild Lettuce.
402 villosa, Jacq. (Mulgedium, Cass.)
403 Floridana, Gærtn. (Mulgedium, Cass.)
404 foliosa, (Lea's Cat. as Mulgedium leucophæum DC.)

SONCHUS, L.
405 oleraceus, L. Common Sow-Thistle.
406 asper, Vill. Spiny-leaved Sow-Thistle.

LOBELIACEÆ.

LOBELIA, L.
407 cardinalis, L. Cardinal flower.
408 syphilitica, L. Great Lobelia.
409 inflata, L. Indian Tobacco.
410 spicata, Lam. (Clark's Cat.)

CAMPANULACEÆ.

CAMPANULA, Tourn.
411 aparinoides, Pursh. Marsh Bellflower. (Mr. T. W. Spurlock.)

412 Americana, L. Tall Bell-flower.

SPECULARIA, Heister.

413 perfoliata, A. DC. Veuns' Looking Glass.

ERICACEÆ.

CHIMAPHILA, Pursh.

414 maculata, Pursh. Spotted Wintergreen. (Clark's Cat.)

MONOTROPA, L.

415 uniflora, L. Indian Pipe. Corpse Plant.
416 Hypopitys, L. Pine sap. False Beech Drops. (Clark's Cat.)

EBENACEÆ.

DIOSPYROS, L.

417 Virginiana, L. Common Persimmon.

PLANTAGINACEÆ.

PLANTAGO. L.

418 major, L. Common Plantain.
419 lanceolata. L. Ribgrass. Ripplegrass. English Plantain.

PRIMULACEÆ.

DODECATHEON, L.

420 Meadia, L. American Cowslip. Shooting Star.

LYSIMACHIA, Tourn.

421 stricta, Ait.
422 quadrifolia, L.

STEIRONEMA, Raf. (Lysimachia, L.)

423 ciliatum, Gray.
424 lanceolatum, Gray. var. hybridum, Gray. (Clark's Cat.)

ANAGALLIS, Tourn.

425 arvensis, L. Common Pimpernel. (T. W. Spurlock.)

SAMOLUS, L.

426 valerandi, L., var. Americanus, Gray. Water Pimpernel, Brook weed.

LENTIBULACEÆ.

UTRICULARIA, L.

427 gibba, L. Bladderwort. (Clark's Cat.)
428 minor, L. Smaller Bladderwort. (Lea's Cat.)

BIGNONIACEÆ.

TECOMA, Juss.

429 radicans, Juss. Trumpet Creeper.

CATALPA, Scop., Walt.

430 bignonioides, Walt. Catalpa. Indian Bean.

MARTYNIA, L.

431 proboscidea, Glox. Unicorn Plant. (Dr. J. H. Hunt.)

OROBANCHACEÆ.

EPIPHEGUS, Nutt.

432 Virginiana, Bart. Beech drops.

CONOPHOLIS, Wallroth.

433 Americana Wallroth. Squaw root. Cancer root. (Mr. T. W. Spurlock.)

APHYLLON, Mitchell.

434 uniflorum, Torr. & Gray. One flowered Cancer root.

SCROPHULARIACEÆ.

VERBASCUM, L.

435 blattaria, L. Moth Mullein.
436 thapsus, L. Common Mullein.

LINARIA, Tourn.

437 vulgaris, Mill. Toad Flax. Butter and Eggs.

SCROPHULARIA, Tourn.

438 nodosa, L. Figwort.

COLLINSIA, Nutt.

439 verna, Nutt. Blue eyed Mary.

CHELONE, Tourn.

440 glabra, L. Turtlehead. Snakehead. (Mr. T. W. Spurlock.)

PENTSTEMON, Mitchell.

441 pubescens, Solander.
442 lævigatus, Solander. (P. Digitalis, Nutt.)

MIMULUS, L.

443 ringens, L. Monkey Flower.
444 alatus, Ait.

CONOBEA, Aublet.

445 multifida, Benth.

GRATIOLA, L. Hedge Hyssop.
446 Virginiana, L.

ILYSANTHES, Raf.
447 gratioloides, Benth. False Pimpernel.

VERONICA, L.
448 Virginica, L. Culver's root. Culver's Physic.
449 anagallis, L. Water speedwell (Lea's Cat.)
450 Americana, L. American Brooklime. (Clark's Cat.)
451 serpyllifolia, L. Thyme leaved speedwell.
452 peregrina, L. Neckweed. Purslane speedwell.
453 arvensis, L. Corn speedwell.
454 agrestis, L. Field speedwell. (Lea's Cat.)

SEYMERIA, Pursh.
455 macrophylla, Nutt. Mullein Foxglove.

GERARDIA, L.
456 purpurea, L. Purple Gerardia.
457 tenuifolia, Vahl. Slender Gerardia.
458 quercifolia, Pursh. Smooth False Foxglove. (Clark's Cat.)

PEDICULARIS, Tourn.
459 Canadensis, L. Common Lousewort. Wood Betony.
460 lanceolata, Michx. (Mr. T. W. Spurlock.)

ACANTHACEÆ.

DIANTHERA, Gronov.
461 Americana, L. Water Willow.

RUELLIA, L. (Dipteracanthus, Nees.)
462 ciliosa, Pursh.
463 strepens, L.

VERBENACEÆ.

VERBENA, L.
464 angustifolia, Michx. (Mr. D. L. James.)
465 hastata, L. Blue Vervain.
466 urticifolia, L. White or nettle-leaved Vervain.
467 stricta, Vent. Hoary Vervain.
468 bracteosa, Michx. (Dr. J. H. Hunt.)

LIPPIA, L.
469 lanceolata, Michx. Fog-fruit.

PHYRMA, L.
470 Leptostachya. L. Lopseed.

LABIATÆ.

TEUCRIUM, L.
471 Canadense, American Germander. Wood Sage.

ISANTHUS, Michx.
472 cæruleus, Michx. False Pennyroyal.

MENTHA, L.
473 viridis, L. Spearmint.
474 piperita, L. Peppermint (Mr. J. L. Taylor.)
475 Canadensis, L. Wild Mint.

LYCOPUS, L.
476 Virginicus, L. Bugleweed.
477 Europæus, L
478 sinuatus, Elliott. (Mr. J. L. Taylor.)

PYCNANTHEMUM, Michx.
479 muticum, Pers., var pilosum, Gray. (Clark's Cat. as P. pilosum, Nutt.)
480 lanceolatum, Pursh.
481 linifolium, Pursh.

MELISSA, L.
482 officinalis, L. Common Balm.

HEDEOMA, Pers.
483 pulegioides, Pers. American Pennyroyal.

COLLINSONIA, L.
484 Canadensis, L. Horse Balm. Stone-root.

MONARDA, L.
485 didyma, L. Oswego Tea. (Clark's Cat.)
486 fistulosa, L. Wild Bergamot.
487 Bradburiana, Beck. (Clark's Cat.)

BLEPHILIA, Raf.
488 hirsuta, Benth.
489 ciliata, Raf. (Lea's Cat.)

LOPANTHUS, Benth. Giant Hyssop.
490 nepetoides, Benth.
491 scrophulariæfolius, Benth. (Mr. J. L. Taylor.)

NEPETA, L.
492 Cataria, L. Catnip.
493 Glechoma, Benth. Ground Ivy. Gill.

SYNANDRA, Nutt.
494 grandiflora, Nutt.

BRUNELLA, Tourn.
495 vulgaris, L. Common Self-heal.

SCUTELLARIA, L. Skullcap.
496 versicolor, Nutt.
497 canescens, Nutt. (Clark's Cat.)
498 nervosa, Pursh.
499 parvula, Michx.
500 lateriflora, L. Mad-dog Skullcap.

MARRUBIUM, L.
501 vulgare, L. Common Horehound.

GALEOPSIS, L.
502 tetrahit, L. Common Hemp Nettle. (Clark's Cat.)

STACHYS, L.
503 palustris, L. Hedge Nettle.
504 aspera, Michx.
505 cordata, Riddell.

LEONURUS, L.
506 Cardiaca, L. Common Motherwort.

LAMIUM, L.
507 amplexicaule, L. Dead Nettle.

BORRAGINACEÆ.

LITHOSPERMUM, Tourn.
508 arvense, L. Corn Gromwell.
509 latifolium, Michx.
510 canescens, Lehm. Hoary Puccoon or Alkanet.

MERTENSIA, Roth.
511 Virginica, DC. Virginian Cowslip or Lungwort.

MYOSOTIS, L. Forget-me-not.
512 verna, Nutt. (Clark's Cat.)

ECHINOSPERMUM, Swartz.
513 lappula, Lehm. Stickseed.
514 Virginicum, Lehm. Beggar's Lice. (Cynoglossum Morisoni, DC.)

CYNOGLOSSUM, Tourn.
515 officinale, L. Common Hound's Tongue.
516 Virginicum, L. Wild Comfrey.

HELIOTROPIUM, Tourn. (Heliophytum, Cham., DC.)
517 Indicum, DC. Indian Heliotrope.

HYDROPHYLLACEÆ.

HYDROPHYLLUM, L. Waterleaf.
518 macrophyllum, Nutt.
519 Virginicum, L. (Lea's Cat.)
520 Canadense, L.
521 appendiculatum, Michx.

PHACELIA, Juss.
522 bipinnatifida, Michx.
523 Purshii, Buckley. Miami Mist.

POLEMONIACEÆ.

POLEMONIUM, Tourn.
524 reptans, L. Greek Valerian.

PHLOX, L.
525 paniculata, L.
526 maculata, L. Wild Sweet William.
527 glaberrima, L. (Clark's Cat.)
528 divaricata, L. Common Phlox.

CONVOLVULACEÆ.

IPOMŒA, L.
529 purpurea, Lam. Common Morning Glory.
530 nil, Roth. Smaller Morning Glory.
531 lacunosa, L.
532 pandurata, Meyer. Wild Potato Vine. Man-of-the-Earth.

CONVOLVULUS, L.
533 arvensis, L. Bindweed (Clark's Cat.)
534 sepium, L. (Calystegia sepium, R. Br.)
535 spithamæa, L. (Calystegia spithamæa, Pursh.)

CUSCUTA, Tourn.
536 Gronovii, Tourn. Dodder.

SOLANACEÆ.

SOLANUM, Tourn.
537 Dulcamara, L. Bitter-sweet. (Clark's Cat.)
538 nigrum, L. Common Nightshade.
539 Carolinense, L. Horse-Nettle.

PHYSALIS, L. Ground Cherry.
540 pubescens, L.
541 Virginica, Mill. (P. viscosa, L.)
542 lanceolata, Michx. (P. Pennsylvanica, L. Clark's Cat.)

NICANDRA, Adans.
543 physaloides, Gærtn. Apple of Peru. (Dr. J. H. Hunt.)

DATURA, L.
544 stramonium, L. Thorn Apple.
545 Tatula, L. Purple Thorn Apple.
546 Metel, Locke. (Clark's Cat).

GENTIANACEÆ.

SABBATIA, Adans.
547 angularis, Pursh.

FRASERA, Walt.
548 Carolinensis, Walt. American Columbo.

GENTIANA, L.
549 quinqueflora, Lam. Five Flowered Gentian. (Clark's Cat.)
550 Andrewsii Griseb. Closed Gentian (Lea's Cat.)
551 saponaria, L. Soapwort, Gentian. (Clark's Cat).

OBOLARIA, L.
552 Virginica, L.

APOCYNACEÆ.

APOCYNUM, Tourn.
553 androsæmifolium, L. Spreading Dogbane. (Clark's Cat.)
554 cannabinum, L. Indian Hemp.

ASCLEPIADACEÆ.

ASCLEPIAS, L.
555 Cornuti, Decaisne. Common Milkweed.
556 phytolaccoides, Pursh. Poke Milkweed.
557 purpurascens, L. Purple Milkweed.
558 quadrifolia, Jacq. Four leaved M.
559 incarnata, L. Swamp Milkweed.
560 tuberosa, L. Butterfly Weed

ACERATES, Ell.
561 viridiflora, Ell. Green Milkweed. (Clark's Cat.)

ENSLENIA, Nutt.
562 albida, Nutt.

GONOLOBUS, Michx.
563 lævis, Michx. (Clark's Cat.)

OLEACEÆ.

FRAXINUS, Tourn.
564 Americana, L. White Ash.
565 sambucifolia, Lam. Black or Water Ash. (Clark's Cat.)
566 quadrangulata, Michx. Blue Ash.

ARISTOLOCHIACEÆ.

ASARUM, Tourn.
567 canadense, L. Wild Ginger.

ARISTOLOCHIA, Tourn.
568 serpentaria, L. Virginia Snakeroot.

NYCTAGINACEÆ.

OXYBAPHUS, Vahl.
569 nyctagineus, Sweet. (Mr. T. W. Spurlock.)

PHYTOLACCACEÆ.

PHYTOLACCA, Tourn.
570 decandra, L. Pokeweed, Pigeon Berry.

CHENOPODIACEÆ.

CHENOPODIUM, L.
571 polyspermum, L.
572 album, L. Lamb's Quarters, Pig Weed.
573 urbicum, L. (Clark's Cat.)
574 Botrys, L. Jerusalem Oak, Feather Geranium.
575 ambrosioides, L. Mexican Tea. (Mr. J. L. Taylor.)
var. anthelminticum, Gray. Wormseed. (Clark's Cat.)

AMARANTACEÆ.

AMARANTUS.
576 hypochondriacus, L.
577 retroflexus, L.
578 albus, L.
579 spinosus, L. Thory Amaranth.
580 lividus, L.

ACNIDA, L.
581 cannabina, L. Water Hemp. (Clark's Cat.)

IRESINE, P. Browne.
582 celosioides, L. (Clark's Cat.)

POLYGONACEÆ.

POLYGONUM, L.

583 orientale, L. Prince's Feather.
584 Pennsylvanicum, L.
585 lapathifolium, Ait. (Clark's Cat.)
586 Persecaria, L. Lady's Thumb.
587 Hydropiper, L. Common Smart weed. Water pepper.
588 hydropiperoides, Michx. Wild Water pepper.
589 amphibium, L. Water Persecaria. (Lea's Cat.)
590 Virginianum, L.
591 aviculare, L. Knotgrass Door weed.
592 erectum, L.
593 arifolium, L. Halberd leaved Tear Thumb. (Clark's Cat.)
594 sagittatum, L. Arrow leaved Tear Thumb.
595 Convolvulus, L. Black Bindweed. (Mr. J. L. Taylor.)
596 dumetorum, L.. var. scandens, Gray.

FAGOPYRUM, Tourn.

597 esculentum, Mœnch. Buckwheat.

RUMEX, L.

598 altissimus, Wood. Pale Dock. (R. Brittanica, L.)
599 Britannica, L. Great Water Dock. (R. orbiculatus, Gray. Lea's Cat. as R. hydrolapathum, Hends.)
600 crispus, L. Curled Dick.
601 obtusifolius, L. Bitter Dock. (Mr. J. L. Taylor.)
602 Acetosella, L. Field or sheep Sorrel.

LAURACEÆ.

SASSAFRAS, Rees.

603 officinale, Nees. Sassafras.

LINDERA, Thunberg.

604 Benzoin, Meisner. Spice Bush. Benjamin Bush.

THYMELEACEÆ.

DIRCA, L.

605 palustris, L. Leatherwood. Moosewood.

LORANTHACEÆ.

PHORADENDRON, Nutt.

606 flavescens, Nutt. American Mistletoe.

SAURURACEÆ.

SAURURUS, L.

607 cernuus, L. Lizard's Tail.

CERATOPHYLLACEÆ.

CERATOPHYLLUM, L.

608 demersum, L. Honewort. (Mr. D. L. James.)

CALLITRICHACEÆ.

CALLITRICHE, L.

609 verna, L. Water Starwort. (Lea's Cat.)

EUPHORBIACEÆ.

EUPHORBIA, L. Spurge.

610 maculata, Pers.
611 hypericifolia, L.
612 marginata, Pursh.
613 corollata, L.
614 dentata, Michx.
615 platyphylla, L. (Lea's Cat.)
616 obtusata, Pursh. (Clark's Cat.)
617 Peplus, L. (Clarke's Cat.)
618 commutata, Engelm.

ACALYPHA, L.

619 Virginica, L. Three-seeded Mercury.
620 Caroliniana, Walt, Ell. (Lea's Cat.)

URTICACEÆ.

ULMUS, L.

621 fulva, Mich. Slippery or Red Elm.
622 Americana, L. (pl. Clayt.), Willd. American or White Elm.
623 racemosa, Thomas. Corky White Elm.

CELTIS, Tourn.

624 occidentalis, L. Sugarberry. Hackberry.

MORUS, Tourn.

625 rubra, L. Red Mulberry.
626 alba, L. White Mulberry.

MACLURA, Nutt.

627 aurantiaca, Nutt. Osage Orange.

URTICA, Tourn.

628 gracilis, Ait.
629 dioica, L. Stinging Nettle.

LAPORTEA, Gaudichaud.
630 Canadensis, Gaudichaud. Wood Nettle.

PILEA, Lindl.
631 pumila, Gray. Richweed, Clearweed.

BŒHMERIA, Jacq.
632 cylindrica, Willd. False Nettle.

PARIETARIA, Tourn.
633 Pennsylvanica, Muhl. American Pellitory. (Clark's Cat.)

CANNABIS, Tourn.
634 sativa, L. Hemp.

HUMULUS, L.
635 Lupulus, L. Common Hop.

PLATANACEÆ.

PLATANUS, L.
636 occidentalis, L. American Plane or Sycamore.

JUGLANDACEÆ.

JUGLANS, L.
637 cinerea, L. Butternut.
638 nigra, L. Black Walnut.

CARYA, Nutt.
639 alba, Nutt. Shell Bark Hickory.
640 sulcata, Nutt. Thick Shell Bark Hickory.
641 tomentosa, Nutt. Mocker nut. (Clark's Cat.)
642 porcina, Nutt. Pig Nut or Broom Hickory.
643 amara, Nutt. Bitter Nut or Swamp Hickory.

CUPULIFERÆ.

QUERCUS, L.
644 alba, L. White Oak.
645 obtusiloba, Michx. Post Oak. (Lea's Cat.)
646 macrocarpa. Michx. Bur Oak. Overcup White Oak.
647 bicolor, Willd Swamp White Oak. (Mr. J. L. Taylor.)
648 Prinus, L. Chestnut Oak. var. acuminata, Michx. Yellow Chestnut Oak.
649 Phellos, L. Upland Willow Oak. (Mr. S. T. Carley.)
650 imbricaria, Michx. Laurel or Shingle Oak.
651 Leana, Nutt. Lea's Oak.
652 coccinea, Wang., var. tinctoria, Gray. Yellow Barked or Black Oak.
653 rubra, L. Red Oak.
654 palustris, DuRoi. Swamp Spanish or Pin Oak.

FAGUS, Tourn.
655 ferruginea, Ait. American Beech.

CORYLUS, Tourn.
656 Americana, Walt. Wild Hazel Nut.

OSTRYA, Micheli.
657 Virginica, Willd. American Hop-Hornbeam, Leverwood.

CARPINUS, L.
658 Americana, Michx. Blue or Water Beech. American Hornbeam.

SALICACEÆ.

SALIX, Tourn.
659 nigra, Marsh. Black Willow.
660 discolor, Muhl. Glaucous Willow. (Lea's Cat.)
661 fragilis, L. Brittle Willow.
662 sericea, Marshall. Silky-leaved Willow. (Clark's Cat.)
663 Babylonica, Tourn. Weeping Willow.
664 alba, L., var. vitellina, Gray. White Willow. (Clark's Cat.)
665 longifolia, Muhl. Long-leaved Willow.

POPULUS, Tourn.
666 grandidentata, Michx. Large toothed aspen.
667 monilifera, Ait. Cotton Wood. Necklace Poplar.
668 angulata, Ait. Angled Cotton wood. (Clark's Cat.)
669 balsamifera, L., var. candicans, Gray. Balm of Gilead.
670 dilatata, Ait. Lombardy Poplar.
671 alba, L. White Poplar, Silver Poplar.

CONIFERÆ.

JUNIPERUS, L.
672 Virginiana, L. Red Cedar or Savin.

ARACEÆ.

ARISÆMA, Martius.

673 triphyllum, Torr. Indian Turnip.

674 Dracontium, Schott. Green Dragon.

SYMPLOCARPUS, Salisb.

675 fœtidus, Salisb. Skunk Cabbage.

ACORUS, L.

676 Calamus, L. Sweet Flag. Calamus.

LEMNACEÆ.

LEMNA, L. Duckweed.

677 trisulca, L. (Clark's Cat.)
678 minor, L. (Clark's Cat.)
679 polyrrhiza, L.

TYPHACEÆ.

TYPHA, Tourn.

680 latifolia, L. Cat tail Flag. Reed Mace.

SPARGANIUM, Tourn.

681 ramosum, Hudson. Bur-Reed (Clark's Cat.)
682 simplex, Huds., var. Nuttallii, Gray. (Lea's Cat. as S. Americanum, Nutt.)

NAIADACEÆ.

NAIAS, L.

683 flexilis, Rostk. (Lea's Cat.)

ZANNICHELLIA, Micheli.

684 palustris, L. (Lea's Cat.)

POTAMOGETON, Tourn. Pondweed.

685 natans, L.
686 compressus, L. (Clark's Cat.)
687 pauciflorus, Pursh.
688 pectinatus, L. (Clark's Cat.)

ALISMACEÆ.

ALISMA, L.

689 Plantago, L., var. Americanum Gray. Water Plantain.

SAGITTARIA, L.

690 variabilis, Engelm. Arrowhead.

HYDROCHARIDACEÆ.

ANACHARIS, Richard.

691 Canadensis, Planchon. Waterweed.

ORCHIDACEÆ.

ORCHIS, L.

692 spectabilis, L. Showy Orchis.

HABENARIA, Willd., R. Br.

693 psycoides, Gray. (Clark's Cat.)
694 peramœna, Gray.

GOODYERA, R. Br.

695 pubescens, R. Br. Rattlesnake Plantain. (Clark's Cat.)

SPIRANTHES, Richard. Ladies Tresses.

696 cernua, Richard. (Clark's Cat.)
697 gracilis, Bigelow. (Clark's Cat.)

POGONIA, Juss.

698 pendula, Lindl. (Clark's Cat.)

LIPARIS, Richard.

699 liliifolia, Richard. Tway Blade. (Clark's Cat.)

CORALLORHIZA, Haller. Coral root.

700 odontorhiza, Nutt.
701 innata, R. Br. (Lea's Cat.)
702 multiflora, Nutt. (Lea's Cat.)

APLECTRUM, Nutt.

703 hyemale, Nutt. Puttyroot. Adam and Eve.

CYPRIPEDIUM, L.

704 pubescens, Willd. Larger Yellow Lady's Slipper. (Clark's Cat.)
705 spectabile, Swartz. Showy Lady's Slipper. (Clark's Cat.)

AMARYLLIDACEÆ.

HYPOXIS, L.

706 erecta, L. Star grass.

IRIDACEÆ.

IRIS, L.

707 versicolor, L. Larger Blue Flag. (Clark's Cat.)

SISYRINCHIUM, L.

708 Bermudiana, L. Blue-eyed Grass.

DIOSCOREACEÆ.

DIOSCOREA, Plumier.

709 villosa, L. Wild Yam root.

SMILACEÆ.

SMILAX, Tourn.

710 rotundifolia, L. Common Greenbrier.
711 glauca, Walt.
712 tamnoides, L. (Clark's Cat.)
713 hispida, Muhl.
714 herbacea, L. Carrion Flower.

LILIACEÆ.

TRILLIUM, L.

715 sessile, L.
716 recurvatum, Beck.
717 erectum, L., var. declinatum, Gray. Purple Trillium.
718 cernuum, L. Nodding Trillium. Wake Robin.

MELANTHIUM, Gronov., L.

719 Virginicum, L. Bunch Flower. (Clark's Cat.)

CHAMÆLIRIUM, Willd.

720 luteum, Gray. Blazing Star. (Clark's Cat., as Helonias dioica, L.)

UVULARIA, L.

721 grandiflora, L. Bellwort.

SMILACINA, Desf.

722 racemosa, Desf. False Spikenard.

POLYGONATUM, Tourn.

723 biflorum, Ell. Smaller Solomon's Seal.
724 giganteum, Dietrich. Great Solomon's Seal.

ASPARAGUS, L.

725 officinalis, L. Garden Asparagus.

LILIUM, L.

726 Canadense, L. Wild Yellow Lily. (Clark's Cat.)
727 superbum, L. Turk's-cap Lily. (Clark's Cat.)

ERYTHRONIUM, L.

728 Americanum, Smith. Yellow Adder's Tongue.
729 albidum, Nutt. White Dog's-tooth Violet.

SCILLA, L.

730 Fraseri, Gray. Eastern Quamash. Wild Hyacinth.

ALLIUM, L.

731 cernuum, Roth. Wild Onion.
732 tricoccum, Ait. Wild Leek. (Clark's Cat.)
733 Canadense, Kalm. Wild Garlic. (Clark's Cat.)

JUNCACEÆ.

LUZULA, DC.

734 campestris, DC. Wood Rush.

JUNCUS, L.

735 effusus, L. Common or Soft Rush. (Clark's Cat.)
736 marginatus, Rostkovius.
737 tenuis, Willd.
738 acuminatus, Michx. (Clark's Cat.)
739 scripoides, Lam. (Clark's Cat.)

PONTEDERIACEÆ.

HETERANTHERA. Ruiz and Pav.

740 reniformis, Ruiz and Pav. Mud Plaintain. (Clark's Cat.)

SCHOLLERA, Schreber.

741 graminea, Willd. Water star Grass. (Clark's Cat.)

COMMELYNACEÆ.

COMMELYNA, Dill.

742 Virginica, L. (Mr. T. W. Spurlock, Mr. J. L. Taylor.)

TRADESCANTIA, L.

743 Virginica, L. Common spiderwort.
744 pilosa, Lehm.

CYPERACEÆ.

CYPERUS, L. Galingale.

745 flavescens, L. (Clark's Cat.)
746 diandrus, Torr.
747 inflexus, Muhl. (Lea's Cat.)
748 phymatodes, Muhl.
749 strigosus, L.
750 Lancastriensis. T. C. Porter. (Mr. J. L. Taylor.)

KYLLINGIA, Rottböll.

751 pumila, Michx.

DULICHIUM, Richard.

752 spathaceum, Pers. (Clark's Cat.)

ELEOCHARIS, R. Br. Spike Rush.

753 obtusa, Schultes.
754 palustris, R. Br. Lea's Cat.)
755 intermedia, Schultes.
756 tenuis, Schultes. (Lea's Cat.)
757 acicularis, R. Br. (Lea's Cat.)

SCIRPUS, L. Bull rush. Club rush.

758 pungens, Vahl.
759 validus, Vahl. Great Bull-brush.
760 atrovirens, Muhl. (Clark's Cat.)
761 polyphyllus, Vahl.
762 lineatus, Michx.
763 Eriophorum, Michx. Wool Grass. (Clark's Cat.)

FIMBRISTYLIS, Vahl.

764 autumnalis, Roem and Schult. (Lea's Cat.)

CAREX, L. Sedge.

765 polytrichoides, Muhl. (Lea's Cat.)
766 Willdenovii, Schk. (Lea's Cat.)
767 Steudelii, Kunth.
768 bromoides, Schk. (Lea's Cat.)
769 teretiuscula, Good. (Lea's Cat.)
770 decomposita, Muhl. (Lea's Cat.)
771 vulpinoidea, Michx.
772 stipata, Muhl. (Lea's Cat.)
773 sparganioides, Muhl. (Clark's Cat.)
774 cephalophora, Muhl.
775 Muhlenbergii, Schk. (Lea's Cat.)
776 rosea, Schk.
777 stellulata, L. (Lea's Cat.)
778 scoparia, Schk., var. ——
779 Muskingumensis, Schw. (Lea's Cat.)
780 lagopodioides, Schk., var. cristata, Carey. (Lea's Cat.)
781 straminea, Schk., var. festucacea, Gray. (Lea's Cat.)
782 stricta, Lam. (Lea's Cat.)
783 crinita, Lam. (Lea's Cat.)
784 Shortiana, Dew.
785 granularis, Muhl. (Lea's Cat.)
786 grisea, Wahl. (Lea's Cat.)
787 Davisii, Schw. & Torr. (Lea's Cat.)
788 gracillima, Schw. (Clark's Cat.)
789 virescens, Muhl. (Clark's Cat.)
790 triceps, Michx.
791 Careyana, Torr.
792 laxiflora, Lam.
var. intermedia, Boot. (Clark's Cat.); var. blanda, Gray.
793 oligocarpa, Schk.
794 Hitchcockiana, Dew. (Lea's Cat.)
795 Pennsylvanica, Lam.
796 varia, Muhl.
797 pubescens, Muhl. (Clark's Cat.)
798 miliacea, Muhl.
799 filiformis, L. (Lea's Cat.)
800 lanuginosa, Michx. (Lea's Cat.)
801 riparia, Curtis. (Lea's Cat.)
802 comosa, Boott. (Lea's Cat.)
803 Pseudo-Cyperus, L. (Clark's Cat.)
804 hystricina, Willd.
805 tentaculata, Muhl.
806 intumescens, Rudge.
807 Grayii, Carey. (Lea's Cat.
808 lupulina, Muhl. (Clark's Cat.)
809 squarrosa, L. (Clark's Cat.)
810 stenolepsis, Torr.
811 utriculata, Boott. (Lea's Cat.)

GRAMINEÆ.

LEERSIA, Solander.

812 Virginica, Willd. White Grass. (Clark's Cat.)
813 oryzoides, Swartz. Rice Cut Grass.

ZIZANIA, Gronov.

814 aquatica, L. Indian Rice. (Mr. T. W. Spurlock.)

ALOPECURUS, L.

815 pratensis, L. Meadow Fox-tail. (Clark's Cat.

PHLEUM, L.

816 pratense, L. Timothy Grass.

AGROSTIS, L.

817 perennans, Tuckerm. Thin Grass (Lea's Cat.)
818 scabra, Willd. Hair Grass. (Clark's Cat.)
819 vulgaris, With. Red Top.
820 alba, L. White Bent Grass.

CINNA, L.

821 arundinacea, L. Wood Reed Grass.

MUHLENBERGIA, Schreber.

822 sobolifera, Trin. (Lea's Cat.)
823 Mexicana, Trin.
824 Willdenovii, Trin. (Clark's Cat.)
825 diffusa, Schreber. Nimble Will. (Clark's Cat.)

ELEUSINE, Gærtn.

826 Indica, Gærtn. Crab Grass. Yard Grass.

TRICUSPIS, Beauv.

827 seslerioides, Torr. Tall Red Top.

DIARRHENA, Raf.

828 Americana, Beauv. (Clark's Cat.)

DACTYLIS, L.

829 glomerata, L. Orchard Grass.

EATONIA, Raf.

830 obtusata, Gray. (Lea's Cat.)
831 Pennsylvanica, Gray. (Mr. T. W. Spurlock.)

GLYCERIA, R. Br., Trin.

832 nervata, Trin. Fowl Meadow Grass.
833 fluitans, R. Br. (Lea's Cat.)

POA, L.

834 compressa, L. Wire Grass.
835 pratensis, L. Kentucky Blue Grass.
836 trivialis, L. Roughish Meadow Grass. (Clark's Cat.)

ERAGROSTIS, Beauv.

837 reptans, Beauv.
838 poæoides, Beauv., var. megastachya, Gray.
839 pilosa, Beauv.
840 capillaris, Nees. (Clark's Cat.)

FESTUCA, L.

841 elatior, L. Meadow Fescue. (Clark's Cat.); var. pratensis, Gray. (Lea's Cat.)
842 nutans, Willd. (Lea's Cat.)

BROMUS, L.

843 secalinus, L. Cheat or Chess.
844 racemosus, L. Upright Chess.
845 ciliatus, L., var. purgans, Gray.

UNIOLA, L.

846 latifolia, Michx. Spike Grass. (Clark's Cat.)

ELYMUS, L. Wild Rye.

847 Virginicus, L. (Mr. T. W. Spurlock.)
848 Canadensis, L. (Clark's Cat.)
849 striatus, Willd. (Clark's Cat.)

GYMNOSTICHUM, Schreb.

850 Hystrix, Schreb. Bottle Brush Grass.

DANTHONIA, DC.

851 spicata, Beauv. Wild Oat Grass.

ARRHENATHERUM, Beauv.

852 avenaceum, Beauv. Oat Grass. (Lea's Cat.)

ANTHOXANTHUM, L.

853 odoratum, L. Sweet Venal Grass. (Clark's Cat.)

PHALARIS, L.

854 arundinacea, L. Reed Canary Grass. (Clark's Cat.)

PASPALUM, L.

855 fluitans, Kunth. (Lea's Cat.)

PANICUM, L.

856 sanguinale, L. Common Crab or Finger Grass.
857 proliferum, Lam.
858 capillare, L. Old Witch Grass.
859 latifolium, L. (Clark's Cat.)
860 clandestinum, L.
861 dichotomum, Muhl. (Clark's Cat.)
862 depauperatum, Muhl. (Clark's Cat.)
863 Crus-galli, L. Barnyard Grass.

SETARIA, Beauv.

864 glauca, Beauv. Fox tail.
865 viridis, Beauv. Green Fox tail. Bottle Grass.

ERIANTHUS, Michx.

866 alopecuroides, Ell. Woolly Beard Grass. (Mr. F. W. Langdon.)

ANDROPOGON, L.

867 Virginicus, L. (Clark's Cat.)
868 macrourus, Michx. (Clark's Cat.)

SORGHUM, Pers.

869 nutans, Gray. Indian Grass. Wood Grass.

EQUISETACEÆ.

EQUISETUM, L.

870 arvense, L. Common Horsetail.
871 sylvaticum, L. (Mr. J. L. Taylor.)

872 limosum, L.
873 robustum, Braun. (Lea's Cat.)
874 hyemale, L. Scouring Rush. (Clark's Cat.)

FILICES.

Polypodium, L.

875 incanum, Swartz. (Mr. F. W. Langdon, Dr. R. M. Byrnes.)

Adiantum, L.

876 pedatum, L. Maidenhair.

Pteris, L.

877 aquilina, L. Common Brake. (Clark's Cat.)

Asplenium, L.

878 Trichomanes, L. (Delhi, Dr. Rofelty.)
879 ebeneum, Ait.
880 angustifolium, Michx.
881 thelypteroides, Michx.
882 Filix—fœmina, Bernh.

Camptosorus, Link.

883 rhizophyllus, Link. Walking Leaf. (Clark's Cat.)

Phegopteris, Fee.

884 hexagonoptera, Fee. Beech Fern.

Aspidium, Swartz.

885 Thelypteris, Swartz.
886 Noveboracense, Swartz. (Lea's Cat.)
887 Goldianum, Hook. (Lea's Cat.)
888 marginale, Swartz. (Clark's
889 acrostichoides, Swartz. Shield Fern.

Cystopteris, Bernhardi.

890 bulbifera, Bernh. Bladder Fern.
891 fragilis, Bernh.

Onoclea, L.

892 sensibilis, L. Sensitive Fern.

Osmunda, L.

893 regalis, L. Flowering Fern. (Mr. S. T. Carley.)
894 Claytoniana, L. (Mr. A. G. Weatherby, Mr. T. W. Spurlock.)
895 cinnamomea, L. Cinnamon Fern. (Clark's Cat.)

Botrychium, Swartz.

896 Virginicum, Swartz.
897 ternatum, Swartz., var. lunaroides (Mr. S. T. Carley); var. obliquum, Gray (Mr. S. T. Carley); var. dissectum, Gray (Mr. S. T. Carley).

Ophioglossum, L.

898 vulgatum, L. Adder's Tongue. (Prof. John Hussey.)

CHARACEÆ.

Chara, L.

899 flexilis, Willd. (Clark's Cat.

FUNGI COLLECTED IN VICINITY OF CINCINNATI.

By Thomas G. Lea.

Agaricus, Linn.

1 virosus, Fr. Epicr. Waynesville.
2 pantherinus, DC. Cincinnati.
3 rubescens, Pers. Waynesville.
4 vaginatus, Bull. Cincinnati.
5 procerus, Scop. "
6 mastoideus, Fr. Waynesville.
7 acutesquamosus, Weinn. "
8 clypeolarius, Bull. Cincinnati, Waynesville.
9 melleus, Vahl. Cincinnati.
10 nebularis, Batsch. "
11 ochro-purpureus, Berkl. Cincinnati, Waynesville.
12 phyllophilus, Pers. Waynesville.
13 illudens, Schwein. Cincinnati, Waynesville.
14 cyathiformis, Bull. Waynesville.
15 pruinosus, Fr. Waynesville.
16 laccatus, Scop. Cincinnati.
17 radicatus, Relh. "
18 lachnophyllus, Berkl. Waynesville.
19 velutipes, Curt. Cincinnati.
20 cirrhatus, Fr. Waynesville.
21 dryophilus, Bull. Cincinnati.

22 Leaianus, Berkl. Cincinnati. Waynesville.
23 galericulatus, Scop. "
24 filopes, Bull. Cincinnati.
25 hæmatopus, Pers. Waynesville.
26 muralis, Sow. Cincinnati.
27 umbelliferus, L. Waynesville.
28 campanella, Batsch. Cincinnati, Waynesville.
29 fibula, Bull. Waynesville.
30 salignus, Pers. Cincinnati.
31 pinsitus, Fr. Waynesville.
32 mastrucatus, Fr. "
33 algidus, Fr. "
34 niger, Schwein. Cincinnati, Waynesville.
35 bombycinus, Schæff. Waynesville.
36 rhodopolius, Fr. Waynesville.
37 chrysophæus, Schæff. "
38 clypeatus, L. "
39 durus, Fr. "
40 squarrosus, Mull. Cincinnati.
41 adiposus, Batsch. Cincinnati, Waynesville.
42 mutabilis, Schæff. Cincinnati.
43 lanuginosus, Bull. Waynesv'e.
44 dulcamarus, Pers. "
45 pyriodorus, Pers. "
46 auricomus, Batsch. "
47 fastibilis, Pers. "
48 polychrous, Berkl. "
49 sapineus, Fr. "
50 vervacti, Fr. Cincinnati.
51 semiorbicularis, Bull. Cin'ti.
52 inquilinus, Fr. "
53 furfuraceus, Pers. "
54 siligineus, Fr. Waynesville.
55 mucidoleus, Berk. Cincinnati.
56 crocophyllus, Berk. Waynesv'le.
57 campestris, Linn. (D. L. James, Cincinnati.)
58 sylvaticus, Fr. Waynesville.
59 fabaceus, Berkl. "
60 semiglobatus, Batsch. Cin'ti.
61 fascicularis, Huds. Waynesville.
62 sublateritius, Schæff. Cin'ti.
63 velutinus, Pers. Waynesville.
64 stipatus, Pers. Cincinnati
65 Fimiputris, Bolt. "
66 campanulatus, Linn. "

COPRINUS, Fr.

67 fuscescens, Fr. Cincinnati.
68 micaceus, Fr. "
69 nychthemerus, Fr. Waynesville.
70 plicatilis, Fr. "

CORTINARIUS, Fr.

71 varius, Fr. Waynesville.
72 callochrous, Fr. Cincinnati.
73 cærulescens, Fr. Waynesville.
74 violaceus, Fr. "

PAXILLUS, Fr.

75 porosus, Berkl. Waynesville.
76 flavidus, Berkl. "

HYGROPHORUS, Fr.

77 ceraceus, Fr. Waynesville.
78 eburneus, Fr. "

LACTARIUS, Fr.

79 zonarius, Fr. Waynesville.
80 pargamenus, Fr. "
81 piperatus, Fr. "
82 vellereus, Fr. "
83 vietus, Fr. "
84 volemus, Fr. "
85 subdulcis, Fr. "
86 Calceolus, Berkl. "

RUSSULA, Fr.

87 nitida, Fr. Waynesville.

CANTHARELLUS, Adams.

88 cibarius. Waynesville.

MARASMIUS, Fr.

89 fusco-purpureus, Fr. Cin'ti.
90 erythropus, Fr. "
91 pyrrhocephalus, Berk. Waynesville.
92 nigripes, Fr. Waynesville.
93 Rotula, Fr. Cin'ti, "
94 clavæformis, Berk. "

LENTINUS, Fr.

95 Lecomtei, Fries. Cincinnati.
96 tigrinus, Fr. "
97 cæspitosus, Berk. Waynesville.
98 sulcatus, Berk. Cincinnati.
99 vulpinus, Fr. Waynesville.
100 pelliculosus, Fr. Cincinnati.

PANUS, Fr.

101 conchatus, Fr. Cincinnati, Waynesville.
102 stipticus, Fr. Cincinnati, Waynesville.
103 dealbatus, Berkl. Waynesville.
104 augustatus, Berkl. Waynesville.

SCHIZOPHYLLUM.

105 commune, Fr. (D. L. James, Cincinnati).

LENZITES, Fr.

106 betulina, Fr. Cincinnati, Waynesville.

106* Cratægi, Berkl. Cincinnati.

BOLETUS, Fr.

107 subtomentosus, L. Waynesville.

108 edulis, Bull. Cincinnati.

109 strobilaceus, Scop. Cincinnati, Waynesville.

POLYPORUS, Fr.

110 ovinus, Fr. Waynesville.

111 radicatus, Schwein. Waynesville.

112 leucomelas, Fr. Cincinnati.

113 areularius, Fr. "

114 parvulus, Klotrsch. "

115 Montagnei, Fr. "

116 lentus, Berk. Waynesville.

117 Boucheanus, Fr. Cincinnati, Waynesville.

118 fissus, Berkl. Waynesville.

119 elegans, Fr., var. nummularius. Cincinnati, Waynesville.

120 badius, Schwein. Cincinnati.

121 lucidus, Fr. Cincinnati, Waynesville.

122 Rhipidium, Berkl. Waynesville.

123 intybaceus, Fr. Cincinnati.

124 sulphureus, Fr. Waynesville. (D. L. James, Cincinnati.)

125 hypococcinus, Berkl. Waynesville.

126 mollinsculus, Berkl. Cincinnati.

127 destructor, Fr. Cincinnati.

128 gilvus, Schwein. Cincinnati, Waynesville.

129 Isidioides, Berkl. "

130 adustus, Fr. "

131 nigro-purpurascens, Schwein. Waynesville.

132 endocrocinus, Berkl. Waynesville.

133 galactinus, Berkl. Waynesville.

134 dryophilus, Berkl. Waynesville.

135 resinosus, Fr. Cincinnati.

136 pubescens, Fr. Waynesville.

137 conchifer, Schwein. "

138 fomentarius, Fr. Cincinnati.

139 applanatus, Fr. "

140 conglobatus, Berkl. "

141 cinnabarinus, Fr. Cincinnati, Waynesville.

142 radiatus, Fr. Cincinnati.

143 hirsutus, Fr. "

144 versicolor, Fr. " Waynesville.

145 pargamenus, Fr. Cincinnati.

146 Sullivantii, Mont., var. poris pallidas. Waynesville.

147 virgineus, Schwein. Cincinnati.

148 niger, Berkl. Cincinnati.

149 obliquus, Fr. Waynesville.

150 ferruginosus, Fr. "

151 vulgaris, Fr. "

152 vitreus, Fr. "

153 tenuis, Schwein. Cincinnati.

153* scutellatus, Schw. (D. L. James.)

TRAMETES, Fr.

154 lactea, Berk. Cincinnati.

155 sepium, Berk. Waynesville.

DÆDALEA, Fr.

156 ambigua, Berk. Cincinnati.

157 unicolor, Fr. Waynesville.

158 aurea, Fr. Cincinnati.

159 pallido fulva, Berkl. Cin'ti.

MERULIUS, Fr.

161 tremellosus, Schrad. Cincinnati, Waynesville.

162 incarnatus, Schwein. Cin'ti.

163 porinoides, Fr. Waynesville.

HYDNUM, Linn.

164 diffractum, Berk. Waynesville.

165 infundibulum, Swartz. "

166 repandum, L. "

167 zonatum, Batsch. Cincinnati.

168 adustum, Schwein. Waynesville.

169 flabelliforme, Berk. Cin'ti.

170 coralloides, Scop. Waynesville.

171 erinaceus, Bull. "

172 stratosum, Berkl. Cincinnati.

173 cirrhatum. "

174 Ohiense, Berkl. "

PHLEBIA, Fr.

175 cinnabarina, Schwein. Cin'ti.

CRATERELLUS, Fr.

176 lutescens. Fr.

THELEPHORA, Fr.

177 palmata, Fr. Cincinnati.

178 Schweinitzii. Pk. Waynesville.

179 cuticularis, Berkl. "

180 corrugata, Fr. Cincinnati.

181 alba marginata, Schwein, Mss. Cincinnati.

STEREUM, Fr.

182 fasciatum, Fr. Ohio.
183 lobatum, Fr. Cincinnati.
184 striatum, Fr. Waynesville.
185 complicatum, Fr. Cincinnati, Waynesville.
186 bicolor, Fr. Cincinnati.
187 rubiginosum, Fr. Cincinnati, Waynesville.
188 rugosum, Fr, Epic. Cincinnati, Waynesville.

CORTICUM, Fr.

189 cinerascens, Berk. Cincinnati.
190 ochraceum, Fr. Waynesville.

GUEPINIA.

191 spathularia, Fr. Cincinnati.

CYPHELLA, Fr.

192 galeata, Fr. Cincinnati.

SOLENIA, Pers.

193 ochracea, Hoffm. Cincinnati.

CLAVARIA, L.

194 botrytes, P. Cincinnati.
195 flava, Fr. Waynesvile.
196 fuliginea, P. Cincinnati.
197 subtilis, Pers. Waynesville.
198 pyxidata, Pers. Cincinnati.
199 stricta, Pers. Waynesville.
200 pistillaris, L. "
201 mucida, Pers. Cincinnati.

CALOCERA, Fr.

202 cornea, Fr. Cincinnati.

TYPHULA, Fr.

203 muscicola, Fr. Cincinnati.

TREMELLA, Fr.

204 lutescens, Pers. Waynesville.

HIRNEOLA, Fr.

205 Auricula-Judæ, Fr. (D. L. James, Cincinnati.)

EXIDIA, Fr.

206 glandulosa, Fr. Cincinnati.

PHALLUS, Linn.

207 Dæmonium, Fr. Cincinnati.
208 impudicus, L. (D. L. James, Cincinnati.)

LYCOPERDON, Tourn.

209 pyriforme, Schæff. Cincinnati.
210 gemmatum, Fr. Cincinnati.
211 giganteum, Batsch. (D. L James, Cincinnati.)

GEASTER, Mich.

212 striatus, DC., var. minor. (D. L. James, Cincinnati.)

BOVISTA, Dill.

213 nigrescens, Pers. Waynesville.

SCLERODERMA, P.

214 vulgare. Fr. Cincinnati.

LYCOGALA, Mich.

215 epidendrum, Fr. (J. F. James, (?) Cincinnati.)

FULIGO, Hall.

216 varians, Sommf. Cincinnati.

LEOCARPUS, Lk.

217 fragilis, Dicks. Cincinnati.

LEPIDODERMA.

218 tigrinum, Schrad. Cincinnati.

DIDYMIUM, Schrad.

219 rugulosum, Berk. Cincinnati.

STEMONITES, Gled.

220 fusca, Roth. Cincinnati.

COMATRICHA, Preuss.

221 Friesiana, DeBy. Cincinnati.

LAMPHRODERMA, Rost.

222 physaroides, A. & S., var. subœneus. Cincinnati.

ACYRIA, Hill

223 punicea, P.
224 cinerea, Fl. Dan. Cincinnati.

HEMIARCYRIA, Rost.

225 rubiformis, P. Cincinnati.
226 clavata, Pers. "

TRICHIA, Hill.

227 nigripes, P. Cincinnati.
228 varia, P. "
229 chrysosperma, DC. Cin'ti.

CYATHUS, Pers.

230 striatus, Haller. Cincinnati.
231 vernicosus, DC. (D. L. James. Cincinnati.

CRUCIBULUM, Tul.

232 vulgare, Tulasne. (D.L.James, Cincinnati.)

SPHÆRONEMA, Tode.

233 oxysporum, Berkl. Waynesville.

DIPLODIA, Fr.
231 Mori, Berkl. Cincinnati.

VERMICULARIA.
235 Dematium, Fr. Cincinnati.

CYTISPORA, Fr.
236 carbonacea, Fr. Cincinnati.

SEPTONEMA, Corda.
237 spilomeum, Berk. Cincinnati, Waynesville.

SPORIDESMIUM, Link.
238 atrum, Link. Cincinnati.
239 cellulosum, Fr. "
240 concinnum, Berk. "

PUCCINEA, Pers.
241 graminis Dec. Cincinnati, Waynesville.
242 aculeata, Schwein.
243 Circææ, Pers. Cincinnati.

USTILAGO, Lk.
244 carbo, Tul. Cincinnati.

PHRAGMIDIUM.
245 obtusum, Lk. Cincinnati.

CYSTOPUS, De By.
246 candidus. Lev. Cincinnati.

CRONARTIUM.
247 asclepiadeum. Kze., var. Thesii, Berk. Cincinnati.

ÆCIDIUM, Pers.
248 epilobii, Dec. Cincinnati.
249 compositarum, Marb.
250 euphorbiæ, Pers.
251 podophyllatum, Schwein. Cincinnati.
252 cimicifugatum, Schwein. Cincinnati.

SCORIAS.
253 spongiosa, Fr. Cincinnati.

TUBERCULARIA, Tode.
254 vulgaris, Tode. Cincinnati.

FUSARIUM, Link.
255 lateritium. Nees. Cincinnati.

CLADOSPORIUM, Link.
256 herbarum, Lk. Cincinnati.

MACROSPORIUM, Fries.
257 pinguedinis, Berk. Cin'ti.
258 punctiforme, Berk. "

DACTYLIUM, Ness.
259 roseum, Lk. Cincinnati.

OIDIUM. Link.
260 simile, Berk. Cincinnati.

MORCHELLA, Dill.
261 esculenta, Pers. (D. L. James, Cincinnati.)

GYROMITRA, Fr.
262 esculenta, Pers. Cincinnati.

PEZIZA.
263 Acetabulum, L. Cincinnati.
264 pustulata, Pers. "
265 aurantia, Pers. "
266 occidentalis, Schwein. "
267 floccosa, Schwein. "
268 scutellata, L. "
269 leucostigma, Fr. "
270 coccinea, Jacq. (D. L. James. Cincinnati.)

HELOTIUM, Fr.
271 æruginosum, Fr. Cincinnati.
272 citrinum, Batsch. "

PSILOPEZIA, Berk.
273 nummularia, Berk. Cincinnati.

PATELLARIA, Fr.
274 carpinea, Berk. Cincinnati.

CENANGIUM, Fr.
275 craterium, Fr. Cincinnati.
276 triangulare, Fr. "

GLONIUM.
277 stellatum, Muhl. Cincinnati.

RHYTISMA, Fr.
278 punctatum, Fr. Cincinnati.

HYSTERIUM, Tode.
279 pulicare, var., angustatum, Fr. Cincinnati.
280 elongatum, Wahl. Cincinnati.

DICHÆNA, Fr.
281 faginea, Fr. Cincinnati.

XYLARIA, Hill.
282 digitata, Ehrh. Cincinnati.
283 polymorpha, Pers. Waynesville.
284 Hypoxylon, Grev. Cincinnati.
285 carpophila, Fr. "

PORONIA, Willd.
286 Pocula, Schwein. Cincinnati.

HYPOXYLON, Bull.
287 concentricum, Grev. Cin'ti.
288 coccineum, Bull. Cincinnati.
289 cohærens, Pers. "

290 rubiginosum, Pers.
291 multiforme, Fr. Kentucky Hills, 4 miles from the Ohio River.

HYPOMYCES, Tul.
292 lactifluorum, Schwein. Waynesville.

USTULINA, Tul.
293 vulgaris, Tul. Cincinnati.

DIATRYPE, Fr.
294 atropunctata, Schwein.
295 tinctor, Berk. Cincinnati.
296 disciformis, Hoffm. "

EUTYPA, Tul.
297 spinosa, Pers. Cincinnati.
298 limæformis, Schwein. "

VALSA, Fer.
299 fulvo-pruinata, Berk. Cin'ti.
300 Leaiana, Berk. "
301 convergens, Tode. "
302 quaternata, Pers. "

SPHÆRIA, Hall.
303 confluens, Pers. Waynesville.
304 rhizogena, Berk. Cincinnati.
305 Maydis, Berk. "
306 rhodomphala, Berk. "
307 aquilia, Tode. "
308 crinita, Pers. Cincinnati, Waynesville.
309 Bombarda, Batsch. Cin'ti.
310 coccinea, Pers. "
311 putaminum, Schwein. "
312 argyrostigma, Berk. "
313 herbarum, P. "
314 myriadea, Dec. "

OXYGENA, Pers.
315 faginea, Fr. Cincinnati.

MUCOR, Mich.
316 ramosus, Bull. Waynesville.

ANTENNARIA, Link.
317 pinophila, Nees. Cincinnati.

SCLEROTIUM.
318 semen, Tode. Cincinnati.
319 complanatum, Tode. Cin'ti.

REVIEWS AND BOOK NOTICES.

COUES' "BIRDS OF THE COLORADO VALLEY."*

The appearance of another volume on North American birds, from the pen of so talented and versatile a writer as Dr. Coues, would be, under any circumstances, a matter of congratulation to the ornithological world ; and in the present instance, owing to the popular and instructive nature of the work, is of almost equal interest to the general reader.

Although bearing a sectional title, the work under consideration is not limited in its scope to the particular region whose name it bears, but is in addition, as stated on its title page, "a repository of scientific and popular information concerning North American ornithology." The volume at hand, being Part First of the work, opens with the very

* Department of the Interior | United States Geological Survey of the Territories | F. V. Hayden, U. S. Geologist-in-charge | — | Miscellaneous Publications, No. 11 | — | BIRDS OF THE COLORADO VALLEY | A Repository of | Scientific and Popular Information | concerning | North American Ornithology | By Elliott Coues * * * | Part First | *Passeres* to *Laniidæ* | Bibliographical Appendix | Seventy Illustrations | — | Washington | Government Printing Office | 1878 (8vo—pp. xvi.—807.)

concise letter of transmissal of the author, following which is a prefatory note, by Dr. Hayden, explanatory of the scope and objects of the work. To this succeeds the text of the work proper, occupying five hundred and sixty-five pages, this portion of the work carrying the subject through the *Passeres* (Perching Birds) to and including the *Laniidæ* (Shrikes).

The biographical portion is especially full in respect to the birds inhabiting the region which gives the book its title ; the text is clear of all unnecessary technicalities, and the various families and species are treated of in that peculiarly attractive manner for which our author is so justly celebrated. These species are also accompanied by full descriptions in both Latin and English, making the work of permanent value as a text book of the ornithology of that section.

The subject of the synonymy of North American birds has here received the fullest possible attention, having been "worked up anew from the very bottom, as a matter of original personal investigation admitting of nothing at second-hand." "Not only the birds of the Colorado Valley, but also all others of North America* are thus exhaustively treated, their synonymy and bibliography being at length placed upon a satisfactory basis."

We are glad to observe that the author's investigations into the synonymy of the various species, disturb the current nomenclature to a remarkably slight degree ; and as the work in this respect has been especially thorough, ornithologists may congratulate themselves that the "hard-pan" of ornithological nomenclature has at last been reached, so far as the species here treated are concerned.

In his "Excursus on the Names of Shrikes" (pp. 537-542), the author reviews, in a manner peculiarly his own, many points of scientific and etymological interest, and restores to the genus the Linnæan name of *Lanius*, on what are probably indisputable grounds. Our species of Shrikes, therefore, will in future stand as *Lanius*, instead of *Collurio* or *Collyrio*, as most modern works have them. The generalization, on page 200, that "*migration holds species true ; localization*

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* In this connection, we note the absence of any reference to the synonymy and bibliography of *Regulus cuvieri*, *Parus atricapillus* (proper), *Parus carolinensis*, *Parus hudsonicus*, *Parus rufescens*, *Sitta carolinensis*, and *Sitta pusilla*. The first one hundred and ninety-two pages of the work, in which these should occur, were printed, as we are told in the preface, in 1876, "for publication in a different connection," and the scope of the work *afterward* enlarged to comprehend the whole of North America. This will probably account for what might at first glance appear to be an oversight on the part of the author. It is to be hoped, however, that the publication of the remaining portion of the work will afford an opportunity to rectify these omissions.

lets them slip," is well sustained by the facts cited, and is of interest in its relations to the question of the development of varieties and species.

A most important feature of the work is the Bibliographical Appendix of two hundred and eighteen pages, comprising the "North American section of the Faunal Publication Series," of the Universal Bibliography of Ornithology, upon which the author has been for some years engaged. Here are arranged about fifteen hundred titles (incorrectly stated by the author as "nearly or about one thousand,") embracing "a range of publications from the works of Wilson or Audubon down to the least note on the subject." The period covered ranges from the year 1612 down to the latter part of 1878, with the titles arranged "*verbatim, literatim et punctuatim*," in alphabetical order under each year. The value of this portion of the work is further enhanced by two indexes, one of authors, the other of localities, which greatly facilitate reference to the main bibliography, and the work closes with a copious index to the whole volume exclusive of the bibliographical portion. As the author truly remarks, bibliography is always more or less defective, and it is not surprising that, in a work covering so much ground, a few errors and omissions occur. As regards Ohio ornithology, these are nearly all of minor importance, so far as our observation extends; a notable omission, however, being that of Dr. Kirtland's original list of Ohio birds (*Ohio Geological Survey*, 1838).

Taken as a whole, the volume deserves the highest commendation, both as a model of bibliographical architecture, and as a most important contribution to ornithological science; and the publication of the remainder of the work, which we are informed is nearly completed, will be looked forward to with a peculiar interest. F. W. L.

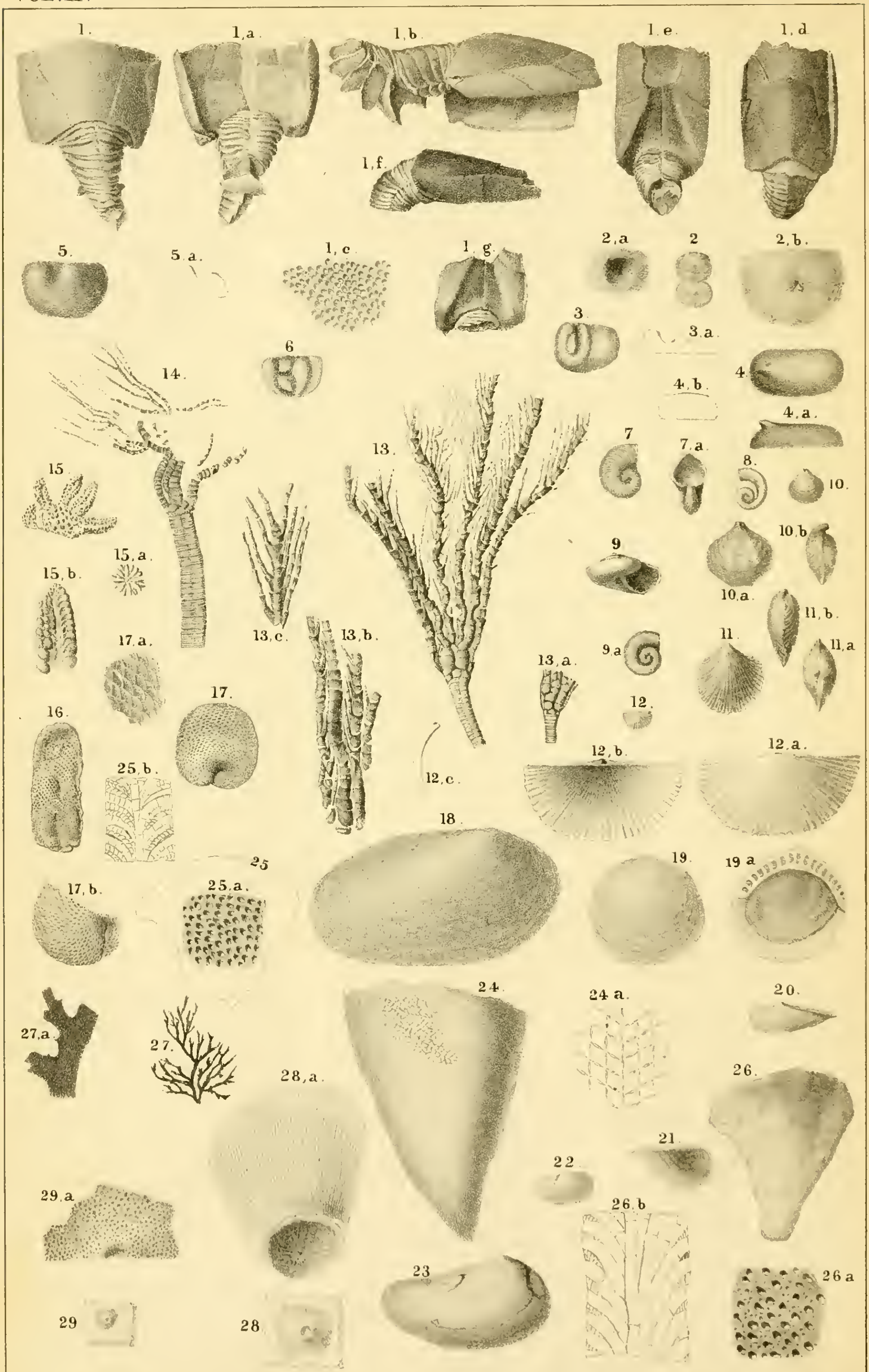

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PLATE VII.

PAGE.

ENOPLOURA BALANOIDES, Meek.

Figs. 1, 1*a* and 1*b*. Dorsal, ventral and lateral views, magnified to 2 diameters. Prof. Wetherby's collection.

1*c*. Dorsal surface of 1*a*, enlarged to 6 diameters.

1*d*, 1*e* and 1*f*. Dorsal, ventral and lateral views of Dr. Newton's specimen. Natural size.

1*g*. Ventral view of Mr. Patterson's specimen. Natural size.

LEPERDITIA RADIATA, ... 9

Fig. 2. View of the two valves. Natural size.

2*a*. View of the interior of a left valve.

2*b*. Right valve, enlarged to 3 diameters, showing the radiating striæ.

LEPERDITIA CREPIFORMIS. 10

Fig. 3. View of left valve, enlarged to 14 diameters.

3*a*. Profile section, to show elevation of ridge.

LEPERDITIA UNICORNIS, ... 10

Fig. 4. View of left valve. Enlarged to 14 diameters.

4*a*. Profile view of left valve, showing height of tubercle.

4*b*. Profile section.

LEPERDITIA BIVERTEX, ... 11

Fig. 5. Lateral view of left valve. Enlarged to 14 diameters.

5*a*. A cardinal profile in outline.

BEYRICHIA PERSULCATA, ... 12

Fig. 6. View of left valve. Enlarged to 16 diameters.

CYRTOLITES NITIDULUS, ... 12

Fig. 7. A side view of a large specimen. Natural size.

7*a*. View of aperture and whorls of same specimen.

MICROCERAS MINUTISSIMUM, ... 13

Fig. 8. A side view. Enlarged to 10 diameters.

CYCLORA DEPRESSA, ... 13

Fig. 9. View of a large specimen, magnified to 10 diameters. The engraving presents the umbilicus too small.

9*a*. View of the spire. Enlarged to 6½ diameters.

ZYGOSPIRA CONCENTRICA, ... 14

Fig. 10. Ventral view. Natural size.

10*a*. Dorsal view of same specimen. Enlarged to 2 diameters.

10*b* Profile view of same. Enlarged.

ORTHIS (?) SECTOSTRIATA, ... 15

Fig. 11. Ventral view of a small specimen. Natural size.

11*a*. Cardinal view.

11*b*. Profile view.

LEPTÆNA PLICATELLA, ... 15

Fig. 12. Ventral view of an adult specimen. Natural size.

12*a*. Ventral view of same, magnified to 7 diameters.

12*b*. Dorsal view of another example magnified to 7 diameters.

12*c*. Profile section of both valves. This figure is erroneous since in all the specimens examined, the convexity is much greater than is here represented.

HETEROCRINUS GENICULATUS, ... 16

Fig. 13. Anterior view of a large specimen, now in the cabinet of Mr. J. Ralston Skinner.

13*a*. Posterior lateral view of a portion of a specimen, showing the position of the azygos interradials. From the cabinet of Mr. J. G. Hine.

13*b*. Posterior view of a specimen preserving only a part of the body and arms, and showing the ventral prolongation.

13*c*. Portion of an arm enlarged to 2 diameters.

DENDROCRINUS (?) CURTUS, ... 18

Fig. 14. Posterior view of the only specimen known.

PALÆASTER FINEI, ... 19

Fig. 15. Dorsal view of a specimen somewhat distorted by pressure.

15*a*. The madreporiform body enlarged to 6 diameters.

15*b*. Ventral view of an arm enlarged to 3 diameters.

LEPIDOLITES ELONGATUS, ... 22

Fig. 16. View of an entire specimen.

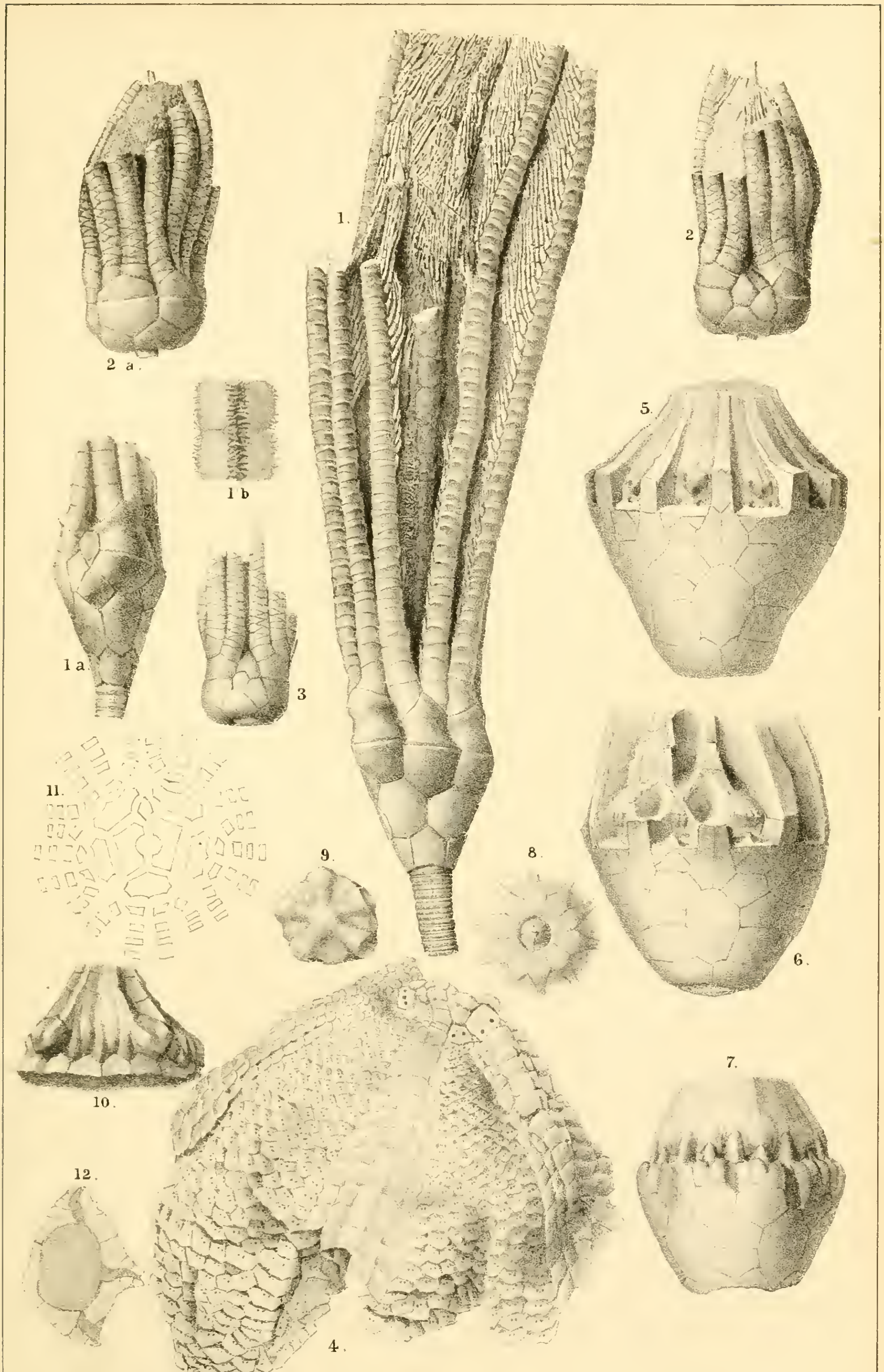
LEPIDOLITES DICKHAUTI, ... 21

Fig. 17. An entire specimen.

17*a*. Enlarged view of some of the imbricating plates.

17*b*. Enlarged view of a specimen flattened vertically.

PLATE VIII.



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THE JOURNAL

OF THE

CINCINNATI SOCIETY OF NATURAL HISTORY.

VOL. II. CINCINNATI, JULY, 1879. No. 2.

ANNUAL ADDRESS OF V. T. CHAMBERS, ESQ.,

PRESIDENT CINCINNATI SOCIETY OF NATURAL HISTORY.

Gentlemen : It has become a custom with scientific societies to require of their presidents, on retiring from office, an address upon some appropriate subject. When the president is a man of science, and competent to the fulfillment of the task, the custom is a good one ; otherwise it is, perhaps, more honored in the breach than the observance. Not claiming for myself any so pretentious title as that of scientist, and belonging to that class already numerous, and becoming each year more numerous, who find in scientific pursuits a profitable and agreeable occupation for such portion of their time as can be spared from business avocations, I must beg your indulgence if I shall not be able to afford you either that amount of instruction or interest which you might derive from an address by one more competent than I am to meet the requirements of my present position ; and I must also remind you that the position was not sought by me, and therefore if I shall fail to interest you, you will have no one to blame but yourselves who have devolved this duty upon me.

I have been somewhat at a loss for a subject for this address. The history and condition of our Society are so fully given in the pages of its JOURNAL, that any further reference thereto would be *de trop;* and my limited time and limited facilities for keeping abreast of the current of scientific discoveries and thought, preclude me from entering upon even a synopsis of the history of science, or of scientific publications during the past year. Indeed, the progress of scientific research, and the subdivision of labor among scientists, in our time, are so great that few of those who are not able to devote their whole time to science, are able to keep themselves fully informed of all that is being done even in any one special branch.

An address upon an occasion like this, to a mixed audience of scientists, and of people who make no pretensions to science, ought to be of a general and semi-popular character, so as to afford something of interest to all. But the question in the present instance is not what such an address *ought* to be, but what under the circumstances it *must* be. And rather than venture upon subjects which a scientist familiar with them might make interesting to you, I have deemed it best to keep within the narrow limits of a specialty to which I have given some attention, and of which have some knowledge. I have accordingly made choice of the subject of THE METAMORPHOSES OF INSECTS AS ILLUSTRATED IN THE TINEID GENUS LITHOCOLLETIS OF ZELLER.

Much that I may have to say will no doubt be familiar to some of you, though in such an audience as this, there are no doubt others to whom the whole subject is *terra incognita.*

The word metamorphoses includes all those changes which an organism undergoes in form and structure in the course of its development from the egg to maturity. In this sense all animals undergo metamorphoses. But in many animals these changes take place so gradually, that there is no sudden change of form, nor any process of ecdysis or moulting of the entire dermal integument. But it has a more restricted meaning, at least in common parlance, such as is given to it when people ordinarily talk of the metamorphoses of an Insect or Crustacean, meaning only those more marked changes of form and structure, which appear to be somewhat sudden, and are accompanied by ecdysis or shedding of the skin, as when the caterpillar changes to the chrysalis, and the latter to the butterfly, or when a larva passes from one stage to another of larval life. These changes are observed to be not only apparently sudden, and accompanied by a moult of the integument, but they are also periodical, and have a definite relation to the amount of food consumed in each stage, and to the temperature of

the medium in which the organism lives; and they are accompanied by well marked changes in the internal structure of the animal. But besides the influence of food and temperature there appears also to be an unknown factor which directs the course of development, and holds in subordination the influences both of food and temperature.

The number of moults which insects undergo varies in different species, and sometimes (under the influence of the unknown factor to which I have alluded) even in the same species. Thus, according to Sir J. Lubbock, *Chloeon dimidiatum*, a neuropterous insect, moults seventeen times; whilst some of the smaller Lepidoptera moult only once in the larval state, once passing into the pupa, and again into the moth or imago as is the case in the genus *Phyllocnistis*; and some as in the genus Nepticula, moult only twice; once when the larvæ becomes a pupa, and again when the pupa becomes a moth. The usual number of skin sheddings among Lepidoptera however is six, including those by which the pupa and the imago are disclosed. But there are many exceptions to this rule. Thus the larvæ of *Sphinx ligustris*, according to Newport, moults six times (but it may be possible that Newport includes in this number the moult of the larva into the pupa state); and Cuvier states that the larva of *Arctia caja* moults five to ten times. It is possible, as Dr. Packard has already suggested, in a note in "*Nature*," that there is some error in this statement. Rennie and Westwood, in their "Insect Transformations," state that caterpillars generally moult five times, but sometimes seven or even ten times. Some confusion as to the number no doubt has grown out of the fact that some authors include the moult by which the caterpillar passes into the pupa state, whilst others exclude it. Including this moult, the ordinary number is five; that is, there are ordinarily five stages of larval life.

Mr. H. W. Edwards has recently, in the pages of the Canadian Entomologist and of Psyche, published many valuable observations on the life histories of our American butterflies, from which it appears that in *Phyciodes tharos*, and in *P. nycteis*, *Danais archippus*, *Satyrus nephele*, *Lycæna pseudargiolus*, *Neonympha sosybius*, and *N. eurythris*, there are five stages; and in *Limenitis arthemis*, and *L. dysippus*, six whilst in *Cœnonympha gemma* there are only four. According to Lintner the larva of the moth, *Ceratomia quadricornis*, passes through five stages; and according to Kirby there is the same number in *Apatura celtis*, and in the female of *Orgyia leucostigma*, whilst there are only four in the male; and *Hemileuca maia* is said "to be one of the few larvæ which passes through" six stages. In *Hyperchiria Io* there are six stages; in *Thyridopteryx ephemeræ formis* only four.

According to Mr. Riley in *Clisiocampa americana*, *Platysamia cecropia*, *Callosamia promethea*, *Telea polyphemus* and *Antheræ yamamai* there are five stages; whilst in *Anisopteryx vernata*, *Anisota rubicunda* and *Paphia glycerium* there are only four; and I believe that Mr. Healy records the same number in the Tineid moth *Gracillaria syringella*. According to my own observations, there are in the Tineid moths of the genera *Antispila* and *Aspidisca* only two larval stages, in *Tischeria* five, and as more fully detailed hereafter there are seven in *Lithocolletis*.

The number of larval stages among Lepidoptera therefore ranges from one to seven, or even ten if the statement as to *Arctia caja* is correct.

I have alluded to the apparent suddenness of the metamorphoses of Lepidoptera. In fact the changes are not so sudden as they appear to be. Concealed within the integument changes have been gradually accomplished, which only became apparent on the sloughing off of the old skin, and these changes have been brought about simply by the rapid growth of some parts, and the arrest of growth or absorption of other parts. They differ from the changes which are observed in the development of a vertebrate, chiefly in their periodicity, and in the casting of the skin, whereby they are made evident: but they are as much the result of growth and absorption as are the metamorphoses of a frog. That which makes the metamorphoses of an insect peculiarly striking, is its apparent suddenness, and its periodicity, especially the former, accompanied as it is by a moult of the integument, whereby a being is disclosed often so widely different from the form in which it had just previously appeared.

Various hypotheses have been suggested to account for the phenomenon of a sudden and complete cast of the integument. It has been suggested that the skin of the larva ceases to grow, and becoming too small for the contained animal, it is cast off, but no explanation is given by this hypothesis why the entire skin ceases all at once to grow, while the growth of the animal continues; nor why, nor how, the animal becomes separated from its skin; and this explanation leaves entirely out of view the periodicity which we shall see characterizes the phenomenon, and its relation to temperature, and quantity of food consumed. Burmeister in his manual suggests that the skin becomes too dry, and is therefore cast off: but he saw himself that such an explanation would explain nothing, and was not at all applicable to larvæ living in water; and besides it is open to all of the objections urged against the preceding hypotheses. The distinguished author of the "Guide to the Study

of Insects," seems to think that there is nothing more remarkable about the metamorphoses of insects than about those of man, each being a mere process of growth and development. But in man there is no cast of the entire integument which occurs periodically in insects.

No satisfactory explanation of the metamorphoses of either vertebrates or articulates has ever been given, or perhaps ever will be given. The inquiry simply resolves itself into the question, why growth and development are what we see them to be, instead of being something else, we know not what—perhaps a mere formless mass of cells.

Prof. A. M. Duncan (*Nature*, v. 7, p. 30) states that "the skin-sheddings (of insects) have a definite relation to the increasing size of the insect, but they are not simple changes of skin, because the old one has become too light for its rapidly growing possessor. They accompany certain important changes within the insect." And the facts which he gives as to the structure of the intestinal canal, support his statement, as also do those subsequently to be given in this address as to certain other organs, in which also the exact relation of the "skin-sheddings" to the increasing size of the larvæ of *Lithocolletis* will be made evident. These facts, or rather facts of the same character as these presently to be given as to *Lithocolletis*, have at various times been stated with reference to other insects.

Thus H. S. Edwards states that the larva of *Phycoides tharos*, in its first stage, measures in parts of an inch .06 in length, in its 2d stage .22, in the 3d .45, and in the fourth form .85 to .90; that is the larva in each stage is *about* twice as long as it was in the preceding stage. He also states that the larva of *Satyrus nephele* in its several stages measures respectively .1, .16, .30, .44 and .95 to 1.2 in length. An approach to a regular ratio of size in the several stages is here apparent, but it is not so distinct as in *P. tharos*. Just here I will add that the larvæ of *Lithocolletis*, especially those of the group of flat larvæ, are more rigid, and less contractile than those of higher groups, and, therefore, afford greater facility for measurement; and besides it does not appear from the observations of Mr. Edwards, or of the other authors whom I shall quote, exactly at what period of the respective larval stages the measurements were made. The measurements ought to be made at exactly corresponding periods of the several stages, and the best period is when the larvæ has ceased to feed at the end of each stage, when the full growth for that stage has been attained. It is at that period that I have made the measurements of *Lithocolletis* hereafter detailed.

In *Neonympha sosybius*, according to Edwards, the lengths in the respective stages are in parts of an inch, .09, .2, .36, .42 and .56. Here in the first three stages the ratio of growth is nearly the same. In *Lycæna pseudargiolus*, Edwards gives .04, .1, .14, .25 and .36. Here also the ratio only appears in the first three stages. In *Neonympha eurytris*, Edwards gives .08, .16, .24 (thus far very regular) then .44, growing to 1.0. In *Coenonympha gemma*, .18, .34, .55, an approximate regularity. In *Phyciodes nycteis*, .06, .18, .24, .34 and .50. In most of these instances very nearly the same ratio of growth is preserved through the first three stages. According to Lintner, *Ceratomia quadricornis*, when it leaves the egg, measures .2, at its first moult it has doubled this length and measures .4, at the 2d .6, at the 3d one inch, and in its last stage grows from 1.6 to 2.75 or even to 3.25. According to Prof. Fernald, *Platysamia cecropia* measures 15, 20, 35 and 50 millimeters in its several stages.

So many of these instances and many others which might be cited, show either a regular ratio in the length of the several larval stages, or at least a near approach thereto, that we are tempted to think that when the ratio seems to fail it does so rather because the larvæ were not measured at exactly corresponding periods of the several stages, or because the elongation or contraction of the larvæ prevented the ratio from appearing to be so regular as it really was, and that it would have been more evident had the measurements been taken from the moulting larvæ at the end of each stage.

As to the quantity of food consumed in each stage, I have few data apart from my own observations upon *Lithocolletis*. Count Dandolo, as quoted by Rennie and Westwood (*loc. cit.*), states that a silk worm just hatched measures 1 line in length; after its 1st moult, 4 lines; after the 2d, 6 lines; after the 3d, 12 lines; after the 4th, 20 lines; and grows to 40 lines before the 5th moult, when it passes into the pupa state. Here is again an approximation to the regular ratio of growth of the several stages; but it does not appear how long after each moult the measurements were made. Dandolo gives the quantity of food consumed by the silk worm in each stage as follows: In the 1st stage, 6 lbs; in the 2d, 18 lbs; in the 3d, 60 lbs; in the 4th, 180 lbs; and in the 5th, 1,098 lbs. Here the quantity of food consumed in each stage was almost exactly three times as much as in the preceding stage, until the last stage when it is six times as much. As will be seen hereafter in *Lithocolletis*, the larvæ in each stage consumes, as nearly as it can be ascertained, exactly three times as much as it did in the preceding stage.

As to the period of duration of each stage, we shall find, also, that there is great regularity, but it is here that the influence of temperature is most distinctly felt. Going over the same species above mentioned, and on the authority of the same authors, I find that *P. tharos* passes 6 days in the egg, 22 in the larva, and 5 in the pupa state, or varying with the season and temperature, 4 in the egg, 22 as larva, and 7 as pupa ; the duration of the egg and pupa together is half that of the larva. But of larvæ hatched in the fall, Mr. Edwards found that the time passed in the egg was 5 days, as larva 26 to 37, and as pupa 30 or more days, according to temperature. An effect, perhaps, of the unknown factor I have referred to, was that whilst the general course of development was as above given, yet such larvæ as hibernated underwent one more moult than those which passed through all their changes in the same season, perhaps though this was the effect of temperature. The larval life of *Danais archippus* lasts from 17 to 25 days, according to temperature. The first larval stage of *Cœnonympha gemma* lasts 6 days in April and August, and 9 in October ; the 2d stage lasts 7 days in May, five in August and 10 in October ; the 3d, 5 days in August and 8 in May, and the 4th stage lasts 10 days in August, including two days spent in moulting. Here the larval life extends over such a period, and the duration of the several stages is so complicated by the effects of varying temperature, that it is impossible to determine how nearly of the same length the several stages would be under the same conditions. *Phyciodes nycteis* passes 8 days in the first stage in July, and 10 in June ; the 2d stage lasts 4 or 5 days; the 3d, three days; and the 4th three to five days; these variations as in the former case depending upon temperature. But here appears the influence of the "unknown factor," which controls the influence of food and temperature. Mr. Edwards states that some larvæ of each brood, the early as well as the later ones, ceased at various times to feed and to grow; their development was arrested, and larvæ of all the broods spent the remainder of the season, and hibernated, in various stages, and underwent the remainder of their transformations the following year: whilst others passed on regularly through all their stages in the same year. Something very similar to this occurs, also, with some larvæ of *Lithocolletis*, as will be shown presently.

Such instances as those above cited show the effect of temperature, but do not so well illustrate the relative lengths of the different stages. But Mr. Gentry states that the first moult of the larva of *Platysamia cecropia* took place June 10th; the 2d, June 18th; the 3d, June 26th;

and the 4th, July 4th. Each of these stages lasted eight days ; but the larva did not begin to spin its cocoon until July 21st, so that the last stage lasted about as long as any three of the previous stages. *Phyciodes tharos* passes (Edwards states) 5 to 6 days in its 1st stage, and the same in its 2d, three days in the 3d stage in summer, but 7 to 14 days in the fall, three to five days in the 4th stage, four to six days in the 5th stage, and 6 to 13 days as pupa, unless "retarded by cold." In *Satyrus nephele* the larva hibernates in the first stage, passes 23 days in its 2d stage in spring, 14 days each in its 3d and 4th stages, and twice fourteen in the 5th, and 14 again as pupa.

These instances might be multiplied indefinitely. They show an approach to a regular period for the duration of each stage; and that there is a regular ratio between the duration of the several stages. But in all of these cases the larvæ may be called long lived; so that they are exposed to change of seasons, and vicissitudes of temperature. These larvæ also feed externally on vegetation. That food and temperature do exercise an influence on growth and development every body knows ; and, therefore, we see that larvæ which are so much exposed to changes of these influences, can not so well display the periodic character of their metamorphoses as larvæ, which are shorter lived, and therefore less exposed to be influenced by changed conditions of life. Besides these comparatively large larvæ feeding externally, and needing to have their food constantly renewed, can not be so well supplied with appropriate nourishment as larvæ, which pass more rapidly through their changes, and live inside of leaves, where nature has supplied them with an abundance of their appropriate food, and which only require therefore to be confined in a moist chamber for a few days without change of food or temperature. The leaf mining larvæ are for these reasons better fitted for accurate observations of this character than the larger larvæ of Butterflies, and from observations on them I arrive at conclusions which are indicated, but not, perhaps, fully established by such cases as I have called your attention to. These conclusions are that food and temperature remaining the same, there is a fixed period in each species for the duration of each stage ; that usually in each species all larval stages are of the same length ; that an alteration of food or temperature, or both, usually alters the duration of each stage, but does not always do so; that is, that usually a given amount of food, and a temperature, which is fixed for each species, produces an amount of growth and development, which necessitates, and in some way produces, a shedding of the skin ; but that occasionally another force manifests itself in overruling the effect of food

and temperature, hastening or retarding the metamorphoses of the species; and that there is a regular ratio between the quantities of food consumed in the several stages of the same larvæ; and another different ratio between the rates of growth in the several stages. These conclusions are indicated I think by such instances as I have already cited, and are more fully established by observations on the life histories of the species of *Lithocolletis* now to be given.

The genus *Lithocolletis*, as defined by Zeller, comprises numerous species of small moths, gaily ornamented with spots and marks, usually of silvery white, upon a ground color of gold, saffron, or reddish orange. They are very small, rarely if ever reaching a body-length of 1-3d of an inch, and agree very closely in form and structure with each other, so that it is impossible to separate them into any well defined sub-genera or group. The larvæ are, without exception, what are known as leaf miners ; that is, they mine or burrow in the parenchyma of leaves ; and each species feeds only in the leaves of a single species of plant, or at most in a very few closely related species, and very few if any true species are known, the larvæ of which feed in leaves of plants that are not closely related to each other. Unlike the moths, the larvæ fall readily into three distinct groups, known as the flat larvæ, the *ornatella* larvæ, and the cylindrical larvæ. The character of the flat group is given in the name of the group; they are greatly flattened, with the sides of the segments somewhat mamilated; and on top or bottom of most of the segments of the body, and sometimes on both surfaces is a macula, that is a spot or ring of darker hue than the remainder of the body. From each side of each segment of the body project three hairs, and just above these on the sides are two others. Their feet, both thoracic and ventral, are membraneous, and are not armed either with the claw, which is usually found on the thoracic feet of caterpillars, or the circlet of tentacles, which usually arm the ventral feet. Their mouth parts, and form of the head, are represented at figure 1, and the mouth parts more highly magnified are shown at figure 2. They consist of the labium, which is divided into an upper and lower lobe (*a* lower, *b* upper), but while the mouth parts, or as they are technically termed, the trophi, remain of this form, no labial palpi can be discovered ; the maxillæ (*e*), or lower jaw, are placed just above the labium, uniting to form the floor of the mouth, but there are no maxillary palpi, unless they are represented by the small organs (*d*); then there are the mandibles (*e*); and the spinneret (*f*), which extends along the surface of the labium beneath the floor formed by the united maxillæ. This form of trophi lasts until the 5th moult, after which the

form of the head and trophi represented at figure 3 is assumed. The form is now very different, but consists of the same organ, with the addition of the rudimentary labial palpi (*g*). The antennæ are represented in figs. 1 and 3 at (*h*). In the first stage, the ocellus or pigment spot is single on each side of the head (*i*), just behind the base of the antennæ, but after the first moult, two eye spots appear on each side (as in fig. 1), and these continue to grow during the first five stages. In these five stages, owing to the form of the larva, and of its trophi, it eats only a few layers of cells of parenchyma next to the cuticle of the leaf, and therefore the size of the mine being ascertained, it is easy to determine not the weight but the comparative quantity of food taken in each stage. For further information as to the genus, I must refer to the various entomological publications of this country and Europe; and as connected more especially with the subject of my present remarks, I refer especiall) to some papers by me in the organ of the Cambridge Entomological Club, PSYCHE, for November and December, 1877, and May to August, 1878, and a note in a later number of the same volume.

In those papers I stated that owing to the difficulty of making suitable observations on larvæ concealed more or less in their mines, and which invariably die on being removed from their mines, I had not then been able to follow any species through all of its larval changes so as to observe its different moults; but that by collecting and observing large numbers of mines and larvæ, and examining and counting the cast skins in the mines, I had arrived at the conclusion, that the number of moults was eight, and could not be less than seven. Since then I have been more successful, and have traced the entire life histories of several species, and I find that the number of stages of larval life is seven. I stated also in PSYCHE, *loc. cit.*, that at certain moults, as I then believed at the 7th in the flat and *ornatella* groups, and at the 5th in the cylindrical group, a change in the form of the trophi from that given at fig. 1 to that of fig. 3 took place. This change does take place; but it occurs at the 5th moult in the first two groups, and at the 3d in the cylindrical group. I also stated that it was at this change that the spinneret is first developed. This is incorrect. It then first becomes perfect, and previously is of no functional importance; but it may be discovered in a rudimentary condition in the first stage of larval life. I also then stated that at each moult the larva adds to its length, the length of the larva at the end of its first stage, and this is true of the first five stages, not of the remaining two. As stated, *loc. cit.*, this rate of growth ceases at the moult at which the change takes place in the form of trophi, but as above just

stated this is at the 3d and 5th moults in the respective groups, and not at the 5th and 7th as I then believed. I have stated, in a preceding part of this address, that I have been unable to discover any trace of labial palpi until this change in the form of the trophi takes place. But it does not necessarily follow that they do not exist as mere rudiments or points of growth. Neither have I observed any trace of the sexual organs until that change takes place; nor of the wings until the last stage of larval life. Yet other observers of larvæ of other insects have detected the genital organs at a much earlier stage, and also the rudiments of the wings. Indeed, so many of the organs of the future butterfly or moth have been detected in a rudimentary condition, in its earliest stages, that it may well be doubted whether any such thing as development, as distinguished from mere growth, takes place after the caterpillar leaves the egg; that is whether there is any differentiation of new parts or organs after the caterpillar is excluded from the egg. After that, the carterpillar and its organs grow; and at stated times some parts grow much more rapidly than others, and some are arrested in their growth. or are even absorbed, so that they can no longer be seen; but it seems highly probable that all the parts and organs of every future stage are present at least as rudiments or points of growth in the caterpillar when it leaves the egg. When one observes only the great and apparently sudden change from larva to pupa, and from pupa to imago, it seems as if there has been all at once a great and almost entire change of form and structure. But when one watches the gradual transformations of one of these semi-transparent larvæ under the microscope, and sees that all of this apparently sudden change is accomplished by a gradual though rapid growth of some parts, and the arrest or absorption of others, he is led to the belief that there has been no differentiation of any new organ, but that the whole change is accomplished simply by growth and absorption of already existing organs.

Swammerdam long ago stated that he "could point out in the larva all the limbs of the future nymph or *culex* concealed beneath the skin;" and this statement is probably substantially true, though its *literal* truth depends upon the period at which the observation is made. They can be "pointed out" in the last stage of larval life, but it would be difficult to point out some of them at earlier stages, however much from analogy we may be inclined to believe that they nevertheless exist. Dr. Packard, in his "Guide to the Study of Insects," states that "the body of the larva is transformed into that of the imago; ring answering to ring, and limb to limb in both; the head of the one is homologous with that of the other, and the

appendages of the larva are homologous with those of the imago." In *Lithocolletis*, I have seen the head and its appendages of the forthcoming larva retracted from the corresponding parts of the skin that is about to be cast. I have seen a larva cease to feed, and when no trace of the contained larva of the next stage could be detected in it, then the skin of the contained larva was gradually loosened from the old skin, and the antennæ, trophi, and legs of the forthcoming larva were gradually retracted from their corresponding parts of the old skin; and at the fifth moult the antennæ of the pupa (and imago), as long as the body of the insect, and composed of a multitude of joints, either of which is as large as the entire antennæ of the larva, are nevertheless withdrawn from the antennæ of the larva. Part by part, and organ by organ, I have under the microscope, in these small larvæ, seen the external parts and organs of each stage withdrawn from the corresponding parts and organs of the preceding stage. Each organ, when it is so withdrawn, differs at first but little in form or size from the part from which it is withdrawn, and within which it was formed, but they grow rapidly, and in a few hours I have seen the long and many-jointed antennæ of the pupa grow from the mere rudiment, as it were, which was withdrawn from the larval antennæ. On one occasion, I saw a rather surprising demonstration of the fact, that ring by ring each segment of the larva corresponds with and is formed within the corresponding segment of the larva of the preceding stage. A larva had ceased to feed, and retired to the middle of its mine as if to moult. Wishing to stain the neural ventral ganglia, as I had frequently done with other insects, I extracted the larva from the mine, and cut off its head, as previous observations had shown that the staining fluid would not act through the larval integument. I let the body remain a short time in the staining fluid, and then observed it in glycerine under the microscope. The staining process was a failure; and as no trace of the new larva could be detected contained within the old, I concluded that the larva was not preparing for its moult, but had ceased to feed for some other reason; when happening to press on the cover glass, to my astonishment the contained or new larva "shot out" from the old larval skin, leaving the perfect old skin, containing an almost perfect tracheal system, looking in fact almost as if the larva had suddenly duplicated itself.

To return, however, to the life histories of *Lithocolletis*, as illustrated by a species from each of the three groups.

I have traced the life histories of many species of the flat group, and they are essentially the same. Taking *Lithocolletis guttifinitella*,

Clem., as our example: if in the latter part of June, or in July or August, we examine the leaves of the poison oak (*Rhustoxico dendron*) we shall find the upper surface of many of them marked with solid whitish blotches, of various sizes, the largest as much as an inch long, by $\frac{1}{4}$ of an inch wide, and perhaps with two or three branches; the smallest barely perceptible specs. These are the mines of *L. guttifinitella*, and the largest may contain half a dozen larvæ, whilst the smallest have only one, the large mines having become confluent with others. Looking closely, or with a lens, we may detect a minute glistening paint on the leaf at the beginning of each mine; this is the egg shell. It is a structureless membrane, containing a few minute pellets of "frass" or excrementitious matter. The egg unhatched has never been seen on a leaf, but I have dissected it out of the moth. It is oval, flat, with yellowish contents, and is .3042 millimeters long, and as the larva, like other larvæ, lies no doubt in a curved position in the egg, it is a little longer than the latter, probably about .3744 mm. long, which we shall presently see is just what its length ought to be if the same ratio of growth prevails in the first as in the succeeding four stages of its life; the youngest larva that I have measured, however, was already several hours old, and measured nearly .4 mm. At this period of its life the mine is a small, whitish speck. Holding the leaf up in the light we see that the frass, as the excrement is technically termed, is deposited in the form of the letter Y, and the larva lies in the fork of the Y, curving its body around and eating in every direction, so that when the larva has attained its full size at the end of its first stage of growth, the mine is usually exactly circular. Then at this stage (which my observations lead me to believe is sixty hours after the time the larva left the egg) it ceases to feed, and retiring to the center of the mine lies quietly across the forks of the Y to undergo its change into the next larval stage. The mine now is circular, with a diameter of 1.19 millimeter, with therefore an area of 1.112 mm., which, since the larva only eats the superficial layers of the parenchyma, in all of its stages as before said, represents actually the size of the pile of food consumed in its first stage. The length of the larva is now .8128 mm., or, .19 mm. less than $\frac{2}{3}$ds the diameter of the mine, but it is difficult to give the diameter of the mine accurately to minute fractions of a mm., and the larva *looks to be* just $\frac{2}{3}$ds the diameter of the mine in length. These are not fancies, nor the result of accidental coincidences in a few cases; they are accurate measurements of numerous larvæ and their mines. It will be found that the length of the larva always bears the same definite ratio to the diameter of the mine: that the size of the mine bears always the same definite ratio to

the size of the mine in the previous stage, which is the same thing as saying that the quantity of food consumed by the larva in each stage always bears the same definite ratio to the quantity consumed in the preceding stage. In each stage it is three times as much as in all of the preceding stages combined; and that at the end of the 2d, 3d, 4th and 5th stages respectively, the length of the larva is increased by exactly the length of the larva at the end of the first stage. I have said that about sixty hours after the larva leaves the mine, it ceases to feed, and places itself across the Y to undergo its moult. At that time it is yellowish white, without maculæ, and with mouth parts as in figs. 1 and 2, and no trace of the larva in its 2d stage is discernible; but in three or four hours, the skin is seen to be somewhat loosened over the posterior segments, and the antennæ and trophi are seen to be partly retracted out of the corresponding parts of the old skin. The body, when the larva ceases to feed, is composed largely of oil globules, which at first are packed densely along the course of the intestine, but afterwards spread and make their way through the tissues, forming two rows, extending through the entire length of the larva, even down into the trophi, and which send out on each side two rows into each segment.

These oil globules are gradually absorbed into the tissues of the body; and by the time the organs are retracted as above stated, the oil globules have almost entirely disappeared. The separation of the contained larva from its old skin appears exactly as if the inner layer of the skin, over the whole extent of the body, had separated from the outer one. After the various organs are retracted as above stated, they are at first soft, white and colorless, but they rapidly harden, and the trophi assume a ferruginous hue, and the larva begins to struggle for release from the old skin, which ruptures across the under side of the suture behind the head and then down the sides; and twelve hours after it ceases to feed, the larva makes its exit from its old skin. It is then but little larger than the larva of the first stage, but it immediately, sometimes before it is entirely free from the old skin, begins to feed voraciously. The oil globules have now entirely disappeared. The larva is at first yellowish white, without maculæ, but in a few hours the hollow elliptical transverse maculæ begin to appear on segments five to nine inclusive, and soon they are distinct on both the dorsal and ventral surfaces of the body, though they are less so on segments 4 and 9 than on the others, and these maculated segments assume a faint, dusky hue. After feeding and growing another sixty hours, the larva again ceases to feed, and retires to the central spot (no longer Y shaped) to undergo its second moult. It is now just 1.6256 mm. long, or just

twice as long as it was at the close of the first stage. Its mine is still circular, and 2.38 mm. in diameter, or just twice the diameter that it had at the end of the first stage.

The area, therefore, is 4.4528 mm., or just four times what it was at the end of the first stage. But the mines of the first stage is included in this area, and, therefore, the amount of mined surface which represents the food consumed in the second stage, is just three times as great as it was in the first stage; while as just stated the larva has only doubled its length, but then it has grown in other directions also. The second moult proceeds precisely like the first, which I have already described. Sixty hours have been spent in feeding, and then twelve are spent in moulting. Three days is the entire length of this, as of each of the first five and of the seventh stages. The larva of the third stage resembles at first that of the second closely, and is but little larger. The maculæ, however, are darker, and the maculated segments are of a deeper smoky hue, and the macula on the fourth segment is trapezoidal, instead of elliptical. Sixty hours more are occupied in feeding, and twelve in moulting, and the larva at the close of this stage measures 2.4384 mm., or three times the length of the larva at the end of its first stage. The mine at this time usually departs somewhat from its circular form, but occasionally circular mines of this age may be found, and these have diameters of 3.57 mm., or three times the diameter of the mine of the first stage, and have an area of 17.711 mm., or four times the area of the mine of the second stage, which, however, is included in it, so that the area mined in the third stage, and which represents the amount of food consumed in it, is three times as great as that mined in the first and second stages combined. The process of moulting is precisely as in the two previous stages.

In the fourth stage, the maculæ are still more distinct, and a new trapezoidal macula appears on the third segment, and the maculated segments are of a still deeper smoky hue. But the form of the mine is now so irregular that its area can not be accurately determined; still one can easily determine that if it is not exactly four times as large as it was at the end of the third stage, the difference must be very small indeed, and I am convinced that the same ratio still prevails. The length of the larva at the end of the first stage has again been added, and at the end of this, the fourth stage, the larva is four times as long as it then was, that is, it is now 3.35 mm. and a fraction. Sixty hours have again been spent in feeding, and twelve in moulting, and the process of moulting is precisely what we have seen it to be in the three previous stages, and the larva enters its fifth stage.

In the fifth stage, the maculated segments are of a deep, smoky hue, to the naked eye almost black, the maculæ also are of a darker color, and the posterior line of a new one appears on the 2d segment, and a new ellipsoid one appears on the eleventh segment. Sixty hours are spent in feeding, and twelve in moulting again, and at the time of the moult the larva is 4.164 mm. long, or five times as long as it was at the end of the first stage. The mine is now so irregular in outline that its area can not be determined accurately, but the same or nearly the same ratio evidently still prevails. The process of moulting is the same as at the preceding moult, but the result is a creature of very different form. Ring by ring, and organ by organ is still withdrawn from the corresponding parts of the old skin, but the new organs so withdrawn, are now very different from the old, as may be seen by comparing figs. 1 and 3. (In the latter the labium and maxillæ are seen protruded to their full extent; they are capable of retraction so as to be no larger than the other organs, as shown in fig 4.) In the 5th stage, the mandibles are multidentate and formed for feeding. In the 6th they consist each of only a single small tooth, and are placed so wide apart that they can not be used for biting food. The maxillæ present a totally different appearance (fig. 3 *c*, and fig 2 *c*), as do also the labium and its palpi fig. 3 *a* and *g*, and fig. 2 *a* and *b*. Indeed no labial palpi have heretofore been observed.

The spinneret (figs. 2 and 3 *f*) appears now to be fully developed; nevertheless, it still does not perform its functions. The mandibles and maxillæ, as stated, have changed greatly in form, and there are now no organs of mastication, but none are needed, for the larva eats no more. It has finished feeding in its fifth stage, and its sixth and seventh stages are stages of developmental growth. During the preceding stages the oil globules have been nearly all consumed at each moult, but there has been a small residium left at each, and the quantity of the residium has increased at each moult. After the fifth moult the quantity is large, the larva in its sixth and seventh stages being largely composed of them. The form of the body undergoes but little change in the first five stages, only becoming a little thickened vertically. It is still a "flat" larva. In the fifth moult the larva thickens still more vertically; and in the sixth stage, though still depressed, can not be called flat. The feet are still as they were in the preceding stages. The maculæ and the smoky hue, however, have entirely disappeared, and the larva is white, with an orange spot in each side of the anterior margin of the first thoracic segment, produced by a collection of yellow oil globules. As the larva does not eat, of course

the mine is enlarged no more, neither does the larva increase in length; it is still of the length of the larva at the end of the fifth stage. The ratio of growth has ceased. The body is less rigid and more contractile, and the head, hitherto in the axis of the body, is now somewhat deflexed. This stage lasts only half as long as each of the previous stages, about thirty-six hours, and at the sixth moult, as in the previous moults, each organ can be seen to be retracted out of the corresponding part of the larval skin. The larva, in its seventh stage, is at first scarcely distinguishable from the sixth stage larva; it is only a little less depressed, but it becomes gradually more cylindrical in the latter part of this stage. It does not feed, and there is no increase in length, nor is the size of the mine increased. This stage again lasts three days, and near the end of it, owing to the changes going on within it, by which it becomes a pupa, it becomes distinctly cylindrical, and is no longer a "flat" larva. The spinneret and silk glands are more fully developed, and capable of use, and they are brought into use. After passing into this stage the larva remains quiet for some hours, then it turns upon its back and spins a narrow web along the inner surface of the loosened upper cuticle of the leaf, whereby a narrow fold is made in the cuticle, so that a slight curve is given to that part of the leaf, and thus the mine is made more roomy. Then the larva turns again on to its ventral surface, and spins beneath it a circular floor of fine white silk, the diameter of which is a little greater than the length of the larva ; then turning again on to its back, it spins over it a circular roof which is united to the floor of the mine all around its edges, and its coccoonet is complete. It then turns again on to its ventral surface, and rests quietly to undergo its seventh moult; that by which it passes into the pupa state. It has now been in its seventh stage about two days and a half, and in twelve hours more its change is complete. But how is this change effected? Just as were its previous changes, by the absorption of some organs, or the arrest of their growth, and by the rapid growth of others. If about six hours after the completion of the cocoonet, the larva be removed from the mine, it is found to be no longer a flat larva; it has become almost cylindrical, whilst the thoracic feet are much enlarged and appear as mamillary projections, and the arrangement of the oil globules is the same as we have seen it to be just previous to each of the preceding moults. A little later we shall see that great changes have taken place in the head, though up to this time none of the organs of the forthcoming pupa can be perceived. As in the preceding moults, the eye-spots, antennæ and trophi are gradually retracted from their corresponding parts of the old skir, and at

first do not appear to be different in form from those of the larva. In fact, it looks like only the larva in an eighth stage; but it is in fact the pupa. It differs only in form from the preceding larval stage by being more cylindrical, slightly constricted behind the thorax, the mandibles are reduced greatly in size; the maxillæ are mere small fleshy lobes, similar to the labial palpi, but a little larger; and the labrum and labium are also small and membraneous. The antennæ at first scarcely differ from those of the preceding stage. There are no ventral feet, and the thoracic feet are merely fleshy, mamillary bulbs; and minute sacks, the rudiments of the wings, may be observed on each side of the thorax. Still the creature looks much more like a larva than it does like the pupa into which it will soon grow. It does not remain long in this condition. The head and its appendages, the antennæ and trophi, are slowly retracted; the eye spots are drawn together (those of each side) under the head, and form the eye of the future imago, and when the head is fully retracted they will be found as far back as the middle of the first thoracic segment of the old skin. The antennæ and parts of the trophi grow rapidly. At first they show no sign of articulations. The maxillæ grow into two fleshy appendages stretched side by side in front of the head; and the labial palpi appear beside but beneath them, and smaller. The antennæ grow more rapidly, turn upon themselves, and finally their verniform convolutions fill each side of the head of the larval skin. The head at this stage is represented at fig. 4, and if we remove it from the larval skin, and extend the antennæ and trophi in front, it will appear as in fig. 5. Whilst these changes have been progressing, the cephalotheca, or head shield of the pupa, has also made its appearance, at first as a white, thickened spot on top of the head, growing then into a triangular form, and gradually extending its apex in front over the entire head. The articulations of the antennæ become gradually more distinct, and when these and the trophi have attained their full growth, the antennæ are gradually uncoiled, and together with the trophi are laid beneath the body, as we find them in the pupa. Whilst these changes have been progressing, the muscles and other organs of the thorax and abdomen grow rapidly, and the constriction between the thorax and abdomen becomes deeper, and the wings also have grown from the minute sacks which I have mentioned into their appropriate size and position in the pupa.

The pupa is now fully formed, though it is soft and white, and is still contained within the larval skin. It, however, hardens and darkens rapidly, but even after escaping from the larval skin is still pale and tender. The cephalotheca is produced as a curved acute point in front,

on each side of which are a few minute retrorse teeth, with their anterior margins forming a cutting edge: and each abdominal segment is armed on its dorsal surface with a row of microscopic thorns, pointing backward. All these are useful to the pupa in making its exit partially from the cocoonet and mine, preparatory to disclosing the imago; and the anterior half of the body having by means of this armature been pushed through the opening made in the cocoonet and cuticle of the leaf by the curved point of the cephalotheca, the skin of the pupa splits across the suture behind the cephalotheca, and along the sides of the wings, and the imago emerges. The pupa state in July and August lasts six days, or just twice as long as each of the preceding larval stages (except the sixth, which is, as before shown, only half as long as the others). Thus the duration of the larval life is nineteen and a half days, and that of the pupa six days. How long the imago lives is not known, nor so far as I have been able to learn has any one ever known the imago to feed, and it seems probable that not only does the larva in its first five stages lay up a store of food sufficient for the two succeeding larval stages in which it eats nothing, and for the pupa, but also for the imago.

I have given as fully as the time at my disposal will permit, the life history of *Lithocolletis guttifinitella.* But the cycle of changes is not always the same. I have alluded before to the observations of Mr. Edwards upon the larvæ of some butterflies, showing that while some proceed regularly with their metamorphoses, others of the same brood, from some unknown cause, will even in early summer cease to feed and to grow, but will hibernate, and then pass through the remainder of their changes the next summer; and I have stated that a very similar fact occurs in the larvæ of *Lithocolletis.* Early in August, some larvæ, after having reached this seventh stage, proceed no further with their changes until the next spring, whilst others pass through all of them, and in all probability deposit the eggs from which come another brood in the same season. These dilatory larvæ, do not spin their cocoonets like the others, they make no fold in the upper cuticle of the leaf, but simply spin the floor of their cocoonets, and attach it all around its edges to the upper cuticle, which they also cover with a sheet of silk. This form of cocoonet is as roomy as the other, because it is made to produce a more distinct mamillary bulge of the underside of the leaf; and in it the larva remains, until the following April or May; and its development is not hastened by the warmth of the late summer or fall. The number of larvæ that pursue this course, increases from the first of August on through the season until in the latter part of September no other form of cocoonets will be found.

It is unnecessary to give in detail all the particulars of the life history of *L. ornatella* Cham. In most respects its development does not differ from that of *L. guttifinitella*, Clem., as above given; and it will suffice to point out the particulars in which it does so differ. The larva is not so much flattened, a transverse section of it being more ellipsoid. The maculæ make their appearance on the second to the twelfth segments inclusive, and are solid spots, not mere rings, and are found only on the ventral surface. In the fourth stage they are less distinct, and in the fifth are scarcely discernible. In the fourth stage the larva is tinged with a peculiar greenish hue, and in the remaining stages it is of a bright green color. At the end of the first stage, the larva is .584 mm., at the end of the second 1.168, of the third 1.752, and at the end of the fourth 2.336; that is, in each of these stages, the larva, like *L. guttifinitella*, adds the length of the larva at the the end of the first stage. But at the end of the fifth stage, unlike *guttifinitella*, it adds twice that length, and is 4.10 mm. long.

The same ratio as to the amount of food consumed in the several stages, as in *guttifinitella*, also prevails, so long as it can be ascertained by the size of the mine ; that is, in each stage the larva consumes three times the amount of food that it did in all of the previous stages combined. In the first stage, there is a single ocellus placed as it is in *guttifinitella*, and a second one is added at the second stage, and these continue to grow through the next four stages, but each ocellus is more distinctly composed of separate minute pigment spots. The transformations take place just as in *guttifinitella*. Thus far there is no sufficient reason for separating *L. ornatella* from the flat larvæ, as a group by itself. But at the fifth moult it departs widely from *guttifinitella*; and although it eats nothing after the fifth stage, yet the mandibles instead of being aborted, are larger than they were in the fifth stage, though otherwise the same change in the form of the trophi occurs as we have seen occur in *guttifinitella* ; that is, in the sixth and seventh stages they are of the form shown at figure 3, instead of that shown at figures 1 and 2. A still greater change in the feet takes place at the fifth moult, for in the sixth and seventh stages both the thoracic and ventral feet are as well developed as in any ordinary caterpillar, the ventral feet having the circle of booklets, and the thoracic ones being each armed with a well developed claw. The form of the larvæ also undergoes a great change; it is no longer flat, and the dorsal surface is convex in the sixth stage, and by the end of the seventh the larva has become cylindrical. There may be a reason in the habits of the larva (or *vice versa*) for this different development.

As before stated, the larvæ of the flat group all pupate in the mine. *L. ornatella*, with its large mandibles, cuts a lunate slit in the loosened cuticle of the leaf, and crawls away (which the flat larva is unable to do) to pupate elsewhere. It differs also in its mode of hibernation from the flat larvæ, all of which hibernate as larvæ, while *L. ornatella* hibernates both as larva and pupa; thus, as in its form approaching the cylindrical group, all of which (in this country at least) hibernate as pupa. In its form also, and structure in its last two stages, it is closely allied to the cylindrical group, and it connects both groups by its mining habits, for it mines indifferently either surface of leaves, while all larvæ of the flat group mine only the upper surface, and those of the cylindrical group, with rare exceptions, mine the lower surface. As in the flat larvæ the sixth stage lasts only a day and a half, each of the other stages lasting three days, and the pupa state six in July and August. On each side of the 6th, 7th and 8th segments projects a curious cylindrical tube, unlike anything that I have seen in other larvæ.

The larval history of the cylindrical group is more difficult to trace than that of either of the other groups, because the mine being deeper the larva is better concealed from view. In this group I have traced only the history of *L. robiniella*, Clem., and owing to the irregular form of the mine it is impossible to say anything as to the relative quantity of food consumed in the different stages further than that very nearly if not the same ratio prevails as in the preceding groups. In their first three stages these larvæ are also flattened, but they are narrower, and more elongate than those of the other two groups. Usually the maculæ are absent or indistinct, but in one species *L. tritæniaella*, Cham., they are darker than in the flat larvæ, and the larva itself is of a dusky hue, while the larvæ of the group generally are white or yellowish white. In *L. robiniella* the larva is white, usually immaculate, but sometimes with the maculæ almost black. Each larval stage (except perhaps the fourth) lasts three days, and the same increase of size (that is the length of the larva at the end of the first stage is made in each stage.) For the first four stages (or the first three and part of the fourth), the mine resembles that of a larva of the flat group; but the same change which takes place in the trophi of the other two groups at the fifth moult, and substantially the same change in form which takes place in *L. ornatella*, at the fifth moult, takes place in the cylindrical group at the third moult; that is, the larva then first assumes a cylindrical (or rather at first a moniliform) shape: the legs and feet are well developed, and the trophi assume the form indicated at figure 3. The same ratio of growth in the several stages is also observed as in

the other two groups, with a break at the fourth stage like that which occurs at the sixth stage in the other two groups. Then at the end of the first stage the larva of *L. robiniella*, is .764 mm. long; at the end of the second, 1.528 mm.; at the third, 2.292 mm. But at the end of the fourth stage, while the changes above indicated have taken place, the larva is still of the same length that it was at the end of the third stage. At the end of the fifth stage, however, it has again added the length of the larva of the first stage (.764 mm.), and is now 3.056 mm. long; at the end of the sixth, 3.82; at the end of the seventh, 4.58 mm. Thus unlike the larvæ of the other two groups this larva continues to grow through its sixth and seventh stages, but does not grow in its fourth. The fourth stage here is the representative of the sixth in the other groups. I suggested, as to the greater development of the trophi and feet of *L. ornatella*, as compared with the flat larvæ, that this development was probably connected with the habit of the species of cutting its way out of its mine, and crawling away to pupate. But doubt is thrown on this by the larvæ of the cylindrical group, for their feet and trophi appear in their last stage to be about as well developed as those of *L. ornatella*, yet these larvæ never leave their mines, but like the flat larvæ pupate in their mines, and seem to be unable to crawl when removed from them. There appears to be no sufficient reason why these organs are better developed in the cylindrical larvæ than they are in the flat group; but in both the cylindrical larvæ, and in *L. ornatella*, this development of the trophi and feet is accompanied by the change in the form of the larva, and in the position of the head. The change in the form of the trophi in the flat group is of the same character, but not so great; nor is the change in the form of the larva, nor in the position of the head so great. But I have not time to enter further into these matters, and my chief object has been to show the ratios of size and food of the several larval stages; the relation of the quantity of food, to the increase of size in the several stages; and the relation of both to the periodicity of ecdysis; and to illustrate the manner in which the apparently sudden metamorphoses have been produced gradually, by the rapid growth of some organs, and the arrested growth or absorption of others.

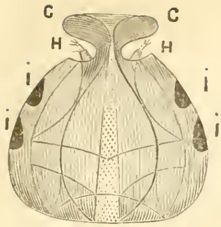


Fig. 1.

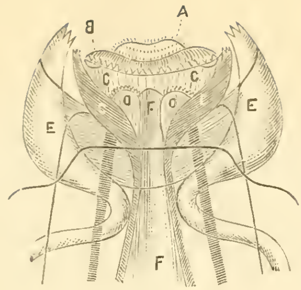
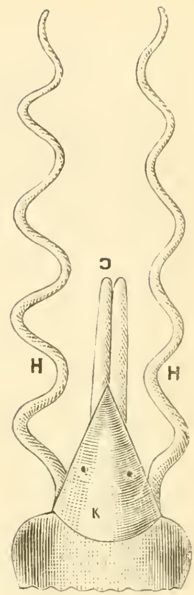


Fig. 2.



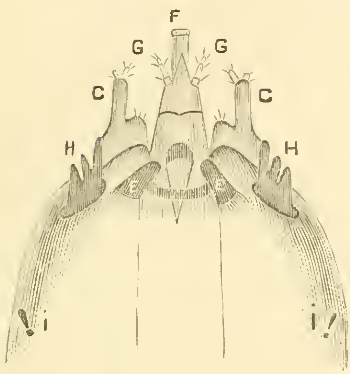


Fig. 3.

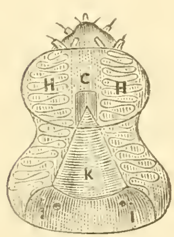


Fig. 4.

Fig. 5.

Fig. 1. Head of *Lithocolletis* larva of the flat and *ornatella* groups in the first five stages, and of the cylindrical group in the first three stages.

Fig. 2. Mouth parts of fig. 1, much magnified.

Fig 3. Head of larva of the flat group after 5th moult, the labium and maxillæ fully extended. They can be retracted until they are no larger than the other organs.

Fig. 4. Same as fig. 3 in the latter part of 7th stage, the labium and maxillæ not extended, and showing the larval head emptied by the retraction of that of the pupa with C, maxillæ; H antennæ, and K cephalotheca of pupa.

Fig. 5. Pupa of fig. 4 removed from larval skin, and with antennæ H, and maxillæ C, extended; K, cephalotheca.

The lettering is the same in all the figures, viz: A, lower; B, upper tube of labium; C, maxillæ, meeting across the upper surface of the labium, and forming the floor of the mouth; D, maxillary palpi (?) or supplemental teeth (?); E, mandibles; F, spinneret; G, labial palpi; H, antennæ; I, eyes.

NOTES ON SOME NEW OR LITTLE KNOWN NORTH AMERICAN LIMNÆIDÆ.

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[Read before the Cincinnati Society of Natural History.]

In his report on the mollusca of Long's expedition (vol. ii., 263, pl. xv., fig. 10, 1824), Say describes this species in the following words:

"Shell large, dilated suboval ; spire short, rapidly diminishing, acute ; whorls about five, rounded, obtusely wrinkled across, body whorl large, the wrinkles very obvious, suture deeply impressed ; aperture subovate, much longer than the spire, within chestnut-brown ; columella white. Length more than one and six-tenths of an inch; greatest diameter one inch.

This remarkably large and fine species was found in Bois Blanc Lake, Northwest Territory, by Dr. Bigsby, to whom I am indebted for specimens. The color is brownish, sometimes lineated across the body-whorl with dull greenish and pale ochraceous; and the chestnut-brown color of the interior of the shell, combined with its large dimensions, distinguish this species from all others yet discovered in this country."

Prof. Haldeman, in his monograph of the *Limnæidæ*, p. 6 (1841), describes, in the following words, his subgenus *Bulimnea :*

"Shell thick in texture, inflated, lip not expanded." To the genus, as thus characterized, he refers the shell in question, which is its type. In the discussion of the species, p. 13, he says, "animal blackish—Binney;" and in reference to habitat, "found in the Northwest Territory—Say (north latitude 48°), and collected by Dr. Binney 'in a swamp in front of the town of Burlington, Vermont, very near the shore of Lake Champlain.' The Northwest Territory must be the original station of this species; whence it has reached a distance of 1,500 miles, with the descending waters. The more rapid current of the Mississippi, and the difference in climate, have doubtless prevented it from establishing itself in the Western States."

In Land and Fresh Water Shells, part ii., 1865, Mr. W. G. Binney refers this shell to Prof. Haldeman's subgenus *Bulimnea*, and says of the geographical distribution, "this is a northern species ranging from Lake Champlain to Michigan," and among the localities there given for specimens in the Smithsonian Institution, we have "Burlington, Vt.," "Lake Champlain, W. Stimpson," and "Lake Superior, Dr. J. S. Newberry." As Burlington is in north latitude 44½°, and Bois Blanc

in 48°, we reach between these points the limits of distribution so far as now authenticated.

Through the industry and success of our Secretary, Dr. J. M. Crawford, who discovered this mollusk during the past summer, on the western side of Green Bay, in upper Michigan, and who kindly obtained and brought home living specimens, we are enabled, not only to clear up slight errors in reference to the shell, but to describe the animal accurately, as well as to give a full discussion of its anatomy. The adult shells from the Green Bay locality much exceed in size those described by Say, and figured by Haldeman and Binney, as the average length is two inches, and specimens frequently reach that of two and three-eighth inches, or nearly 60 mill., while Say's specimens were less than 45 mill., in length. Many of the specimens collected by Dr. Crawford, also attain a diameter of more than one inch, so that, considered in reference to cubic capacity, they are much larger than the specimens described by Say, or figured by either Haldeman or Binney. The color of the shells is a uniform yellowish brown, with none of the highly ornamental outside tints given in Prof. Haldeman's pl. 3., figs. 1 and 3. The inside of the shell is nacreous, and dark purple, or purplish brown when the shell is somewhat thin. The columellar callus is carried around, and spread widely over the inner and upper center of the body-whorl, thickening it, and rendering this part of the shell white interiorly. The lines of growth give the whorls a slightly undulated appearance; and these have a tendency, in a few specimens, to be broken up transversely, on a small area of the front of the shell, directly over the aperture, giving that portion of the body-whorl a somewhat wrinkled appearance. A few very minute transverse striæ may be seen with a good magnifier. The body-whorl makes up the greater part of the shell. Above this it tapers rapidly to the acute apex.

Animal.

The head, rostrum, tentacles and upper and lateral surfaces of the animal are of a dirty yellow, dotted with lighter, yellowish white pigment spots or granules of irregular form. The rostrum is deeply cleft in front, the two lobes being rounded anteriorly and laterally. The oral aperture is situated in the rostral cleft; the tentacles are triangular, attenuated at their extremities, and have a ridge-like process continued from their inner angle upon which the eyes are situated, close to the base of the tentacles; these are long enough to project laterally and anteriorly beyond the lobes of the rostrum. The foot is wide and short, obtusely rounded in front, slightly attenuated and more pointed

behind. It is widest immediately beneath the tentacles. The color, above, is darker than that of the body; the sole is dark bluish or lead-color. The animal is sluggish in its habits, and excessively timid, the slightest disturbance of the water causing it to instantly draw itself into the shell. Though it feeds upon algæ in confinement, my specimens also devour the animals of land snails, and of fresh water mussels with great greediness.

Anatomy.—The Digestive System.

The buccal mass, fig. 1, is oblong-oval, of a bluish or lead-color, and lies before the eyes and between the tentacles, in a cavity of

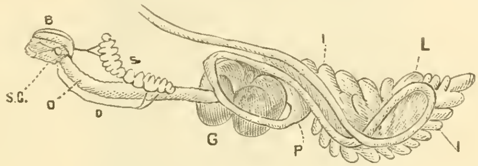

Fig. 1

B, buccal mass ; O, œsophagus ; S, salivary glands ; S G, stomato gastric ganglion ; D, duct of salivary gland ; G, gizzard ; P, pyloras ; I, intestine ; L, liver.

the cephalic part of the rostrum. It is composed of dense muscular tissue, containing the protractors and retractors of the radula, and also a set of muscles so arranged as to vibrate the lateral jaws. It opens anteriorly by the oval aperture which is armed with an upper and two lateral jaws, and posteriorly into the œsophagus, which is long, nearly straight, and passes into the lower anterior side of the distinctly bilobed stomach, at the central line. The salivary glands are white, ramose, and are situated upon the œsophagus, just posteriorly to the nerve collar, and open into the dorsal side of the buccal mass by two long ducts which pass through the nerve collar: these ducts are bifid near the glands, but the branches soon unite. The stomach or crop is composed of two dense subglobular masses, made up of muscle with distinctly striated fibres, the walls being of immense thickness and firmness; the inside is lined with a wrinkled and dense mucous tissue, and contained in the specimens dissected, a large number of small grains of quartz sand.

The pyloric portion of the stomach opens on the upper posterior central line, between the two muscular lobes, and gradually tapers to the intestine proper, which is first folded around the left side, and the front of the stomach over the œsophagus, then back spirally to the posterior portion of the liver, where it is flexed on itself, and passes

forward to open on the right side, and a little below the respiratory orifice. The liver is large, lobed, placed posteriorly, and opens by ducts both into the pyloric portion of the stomach and into the intestine. There is a well developed pancreas.

The Nervous System (fig. 2).

The nervous system consists of the usual collar, forming dense, yellow, irregular, and much-branched ganglia, nearly surrounding the

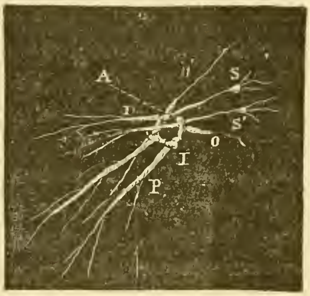

Fig. 2.

A, supra-œsophageal ganglion ; I, infra-œsophageal ganglion ; O O′, optic branches ; S S′, stomato-gastric branches and ganglia ; P, pedal branches ; D, dorsal branches to pulmonary cavity, etc.

œsophagus, just posteriorly to the buccal mass. The supra-œsophageal ganglion is much larger than the infra, and sends filaments to each side of the buccal mass, to the base of the tentacles, to the penis and vagina, and to the floor of the pulmonary cavity. The stomato-gastric ganglion, which lies on each side, at the junction of the œsophagus, the duct of the salivary gland, and the buccal mass, receives a filament, and distributes branches to the buccal mass, to the ducts of the salivary gland, and to the œsophagus, the distribution being much as I have found it in *Ariolimax.* The main branches of the infra are distributed to the foot.

The Reproductive System (fig. 3).

This consists of a very complex hermaphrodite apparatus, opening on the right side by two apertures. The ovary is a flocculent, light yellow mass, folded between the liver and the stomach ; the testicle lies close to it, and anteriorly in the natural position of the organs. The oviduct is comparatively wide and short, and terminates in a distinct vagina, opening exteriorly. The prostate is well defined, and

lies upon the oviduct, extending to the vagina. The genital bladder (?) or *receptaculum seminis*, is large, and communicates with the vagina by a long duct. The vaginal aperture is small, opening on the

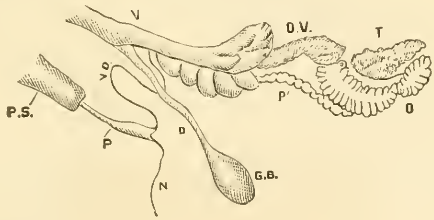

Fig. 3.

T, testicle; O, ovary; O V, oviduct; P′, prostate; G B, receptaculum seminis; D, its duct; V, vagina; V D, vas deferens; P, penis; P S, penis sac; N, nerve.

right side, behind the male orifice. I have been unable to work out the circulatory system, owing to the fact that I have had but a single animal from which to determine the points given, and that was an alcoholic specimen and much hardened. The same is true of the relations and position of the renal organs.

The most striking thing in the anatomy of this species is its close approach, in many of its characters, to the land snails, especially to *Limax*. What this may indicate as to the past history of these creatures is entirely speculative; but the relation is much nearer than that of the genus *Planorbis* to which reference has been made by several authors.

In all their habits these creatures exhibit a close relation to *Physa*. Like them they can float upon the surface, shell downward; in this position, by a peculiar motion of the foot, they swim slowly and awkwardly. They spin threads of mucus upon which they ascend and descend. The upper end of the thread floats, sustained by a bubble of mucus. In all these respects they are like *Physa* and other species of *Limnæa*.

Note on the Planorbis glabratus, Say.

In the Journal Acad. Nat. Sc., (vol. i., p. 280, June, 1818), Mr. Say published his description of *P. glabratus* as follows:

"Shell sinistral; whorls about five, glabrous or obsoletely rugose, polished, destitute of any appearance of carina; spire perfectly regular, a little concave; umbilicus large, regularly and deeply concave; exhibiting all the volutions to the summit; aperture declining, remarkably oblique with respect to the transverse diameter. Breadth nearly nine tenths of an inch."

"Inhabits South Carolina. Cabinet of the Academy. Presented to the Academy by Mr. L'Herminier, of Charleston, an intelligent and zealous naturalist. He assured me that this species inhabits near Charleston. It somewhat resembles large specimens of the *P. trivolvis*, of the American edition of Nicholson's Encyc., but differs in the total absence of carina, and in having a more smooth and polished surface, as well as a declining and more oblique aperture, and a more profonnd and much more regularly concave umbilicus."

Haldeman, in his Monograph of Planorbis, pp. 11 and 12, quotes Say's description and says: "My shells do not agree perfectly with Say's description copied above; yet they most probably constitute the species he had in view. They differ from *P. trivolvis* by having a much more oblique peritreme, the whorls more nearly cylindrical, the diameter increasing less rapidly, and without any tendency to carination upon the left side."

Mr. Binney, in Land and Fresh Water Shells, part ii., p. 106, quotes Say's description and adds: "My figure of *P. glabratus* is drawn from a specimen corresponding with that figured by Haldeman, and generally acknowledged to be this species."

It would seem, from the language used both by Haldeman and Binney, that they had never seen Mr. Say's type of this species. As they would undoubtedly have availed themselves of every means accessible, and as the collection of the Academy was at all times open to them, the presumption is that Mr. Say's type is lost.

It is needless for me to say to those who have given close attention to this species, that the shells known as *P. glabratus* in collections, do not agree with Mr. Say's description in many particulars. They do not have five whorls; they are carinated; they are not glabrous or polished; they are transversely roughened by lines of growth; the umbilicus does not exhibit all the volutions. It is to be remembered that Mr. Say's description is founded upon the idea that the shell is sinistral, an opinion which I hold notwithstanding it is contrary to the general belief of our leading conchologists. I have in my collections specimens labeled *P. glabratus*, by one of the most competent of North American conchologists, that show but a fraction over three whorls; that exhibit, in no case, all the umbilical volutions; that are carinated; that are not polished but roughened by lines of growth. These can not be Mr. Say's shell, nor have I yet been able to obtain a specimen from my exchanges that would meet the requirements of the case.

In 1875 a large collection of shells, from the Miami country of Florida, came into my hands, among which was the true *Planorbis*

glabratus. Not being uncertain, at that time, as to the identity of the shells in my cabinet under the name of *P. glabratus*, I supposed the shells now referred to that species to be new; they have been so called by others, but I am now satisfied that they are the true *P. glabratus* of Say, and that they will assist in removing any of the uncertainties clinging about that species. As will be seen by the specimens exhibited, they have five whorls, they are not carinate, the whorls increase in size very gradually, the umbilicus exhibits all the volutions, the shells are polished, and they meet, in every way, the requirements of Mr. Say's description. It is highly probable, therefore, that the species has not, hitherto, been correctly identified. The species has the southern distribution of many of Mr. Say's shells, and together with the *P. lentus* has probably not been found in northern waters.

Planorbis (Helisoma) duryi, nov. sp. (fig. 4).

Shell thick, shining, straw color, of medium size, slightly waved by indistinct transverse ridges, which upon close examination are seen to

Fig. 4.

be made up of from five to seven lines of increment. *Whorls* about four, rapidly enlarging, the last carinate above to the labrum, subcarinate or obtusely rounded below. *Spire* very regular, flat or very slightly concave. Its outer whorl is sometimes slightly raised on the side before the aperture. *Umbilicus* deep and narrow, not exhibiting all the volutions. *Peristome* acute, sharply angular above, forming the upper carina of the body whorl, less acutely angular below, and deflected upward so as to meet the body whorl at one-third the distance from its base, thus approximating its upper extremity. The lower margin of the aperture is produced beyond the upper, thus rendering the aperture very oblique in profile.

Remarks.

This shell was given me several years ago, by Mr. Charles Dury, who brought it from the Everglades of Florida. It was also among the shells received from the Miami country. It is

one of the most distinctly defined species of *Planorbis* yet found in this country, and certainly one of the most beautiful. The form of the aperture and the characters of the shell in *P. glabratus* and *P. Duryi*, warrant the statement that they do not belong to any group of the Planorbinæ yet established, though we leave them, for the present, in *Helisoma*.

OBSERVATIONS ON BIRDS.

By Charles Dury and L. R. Freeman.

In the following paper are given a number of heretofore unpublished dates of occurrence of birds in the vicinity of Cincinnati, with notes on some of the species : the captures in this locality of *Tringa bairdii*, *Sterna hirundo* and *Helminthophaga chrysoptera* are for the first time recorded. Most of these observations were made in the neighborhood of Avondale, and at Locust Corner, near the Ohio River, about eleven miles above the city. The aquatic birds were taken, with few exceptions, at the mouth of the Little Miami River, where they frequent the bars exposed at low water.

November 22, 1879.

Turdus mustelinus, Gm. *Wood Thrush.*—October 7, 1877.

Turdus fuscescens, Steph. *Wilson's Thrush.*—September 1, 1879, several specimens.

Turdus aliciæ, Bd. *Gray-cheeked Thrush.*—September 16, 1879.

Turdus swainsoni, Cab. *Swainson's Thrush.*—May 18, 1879; September 2 and 21, 1879.

Turdus pallasi, Cab. *Hermit Thrush.*—October 20, 1878.

Regulus calendula, Licht. *Ruby-crowned Kinglet.*—May 6, 1879.

Polioptila cærulea, Scl. *Blue-gray Gnatcatcher.*—September 1, 1879.

Lophophanes bicolor, Bp. *Tufted Titmouse.*—Noticed on May 25, 1878, that a tufted titmouse had selected as its breeding-place the discarded nest of some large bird, in the top of a tall, slim sapling. The little eccentric had deposited six eggs (nearly hatched when found) on a layer of dry grass, which nicely lined quite a large hole which she had excavated in the side of the rough structure.

Sitta canadensis, Linn. *Red-bellied Nuthatch.*—September 15, 1878 ; April 27, 1879.

Certhia familiaris americana, Bp. *Brown Creeper.*—September 23, 1878 ; April 12, 1879.

Thryothorus bewicki, Bp. *Bewick's Wren.*—March 27, 1879, two specimens.

Troglodytes ædon, V. *House Wren.*—April 27, 1879; May 11.

Cistothorus palustris, Bd. *Long-billed Marsh Wren.*—September 21, 1879, seven specimens.

Mniotilta varia, V. *Black-and-white Creeper.*—April 27, 1879; October 12, 1878.

Helmitherus vermivorus, Bp. *Worm-eating Warbler.*—April 28; September 8, 1879. Found rather common during July and the first of August, 1879.

Helminthophaga chrysoptera, Cab. *Golden-winged Warbler.*—July 30 and August 1, 1879, two females.

Helminthophaga pinus, Bd. *Blue-winged Yellow Warbler.*—April 23.

Helminthophaga peregrina, Cab. *Tennessee Warbler.*—October 13, 1878. Rare in spring, but very common—our commonest warbler—in fall. Arrives early in September and remains into the first of October. During the spring migrations, the warblers stay mostly in tall trees; but shortly after their arrival in fall, they all, including such tree-top-frequenting species as *Helminthophaga peregrina*, *Parula americana*, etc., affect the low bushes and weeds. Of about thirty Tennessee Warblers from this locality, the average length of wing was 2.50, of tail 1.83. The measurements given in standard ornithological works are,—wing 2.75, and tail about 1.85.

Parula americana, Bp. *Blue Yellow-backed Warbler.*—July 18, July 31 and August 27, 1879; September 20, 1878. Rather rare in spring; not uncommon in fall.

Perissoglossa tigrina, Bd. *Cape May Warbler.*—May 5, 1879; September 7, 1877; September 22, 1878.

Dendrœca æstiva, Bd. *Yellow Warbler.*—September 15, 1879.

Dendrœca maculosa, Bd. *Black-and-yellow Warbler.*—August 28, 1879.

Dendrœca cæurlea, Bd. *Blue Warbler.*—Common during the last of April, the bulk disappearing in the first week of May. Common from July 18 into the first of August, 1879.

Dendrœca blackburniæ, Bd. *Blackburnian Warbler.*—August 30, 1877; October 18, 1879. Common during the first week of May, 1879.

Dendrœca pennsylvanica, Bd. *Chestnut-sided Warbler.*—April 25, 1877; August 26, 1879.

Dendrœca striata, Bd. *Black-poll Warbler.*—September 1, 1879.

DENDRŒCA CASTANEA, Bd. *Bay-breasted Warbler.*—September 4, 1879; October 20, 1878. Remains common during the first of October.

DENDRŒCA CÆRULESCENS, Bd. *Black-throated Blue Warbler.*—April 26 and August 30, 1879; September 21, 1878.

DENDRŒCA VIRENS. Bd. *Black-throated Green Warbler.*—April 22, 1878; July 23, 1879. Somewhat common about July 30, 1879.

DENDRŒCA PALMARUM, Bd. *Yellow Red-poll Warbler.*—December 24, 1878.

DENDRŒCA DISCOLOR, Bd. *Prairie Warbler.*—May 5, 1879, male.

SIURUS AURICAPILLUS, Bp. *Golden-crowned Thrush.*—October 5, 1878. A specimen obtained on September 16, 1879, was in such exceptionally high plumage that its back was ornamented with several blackish, well-defined, longitudinal streaks. The entire upper parts were of a much darker, richer olive-green than is usual, and the specific markings uncommonly pronounced. The infestation of a large parasite found in the bird's abdomen may have stimulated it to the production of its peculiar characteristics. Measurements are as follow: length 5.88; extent 9.25; wing 2.79; tail 2.13; bill 0.41; tarsus 0.82. (L.R.F.)

OPORORNIS FORMOSUS, Bd. *Kentucky Warbler.*—April 26, 1879. Common during the last of April and the first weeks of May. Numbers of these warblers remain well into the summer; but they become quite scarce by the latter part of July. Frequents both high and low woodland.

GEOTHLYPIS TRICHAS, Cab. *Maryland Yellow-throat.*— April 25 and October 5, 1879. Common by the last of April.

MYIODIOCTES MITRATUS, Aud. *Hooded Warbler.*—August 30, 1879, two females.

MYIODIOCTES CANADENSIS, Bp. *Canadian Fly-catching Warbler.*—Rare in spring, but not so during the last of August and first of September, 1879.

SETOPHAGA RUTICILLA, Sw. *American Redstart.*—April 26, 1879.

VIREOSYLVIA PHILADELPHICUS, Cass. *Philadelphia Vireo.*—September 18, 1877; September 17, 1878.

LANIVIREO SOLITARIUS, Bd. *Solitary Vireo.*—October 19, 1879, several specimens; October 14, 1877. Not rare in 1879.

LANIVIREO FLAVIFRONS, Bd. *Yellow-throated Vireo.*—Common during the last of July, 1879.

VIREO NOVEBORACENSIS, Bp. *White-eyed Vireo.*—Nest with three eggs, July 25, 1879.

PYRANGA RUBRA, V. *Scarlet Tanager.*—April 19, 1878. Common by the last of April.

Pyranga æstiva, V. *Summer Redbird.*—April 24, 1878.

Chrysomitris pinus, Bp. *Pine Linnet.*—Several observed during winter of 1878-79; May, 1879.

Loxia curvirostra americana, Bd. *Red Crossbill.*—Westwood, January, 1879.

Poœcetes gramineus, Bd. *Grass Finch.*—March 25, 1878; October 26, 1878.

Coturniculus passerinus, Bp. *Yellow-winged Sparrow.*—April 27, 1879; November 17, 1878. A rather common summer-resident. The sleek, little, yellow-winged sparrow is a cunning trickster. One was singing on a fence the other day, imitating the *stridor* of a grasshopper. Being interrupted in rather a rude manner, he started hurriedly down the side of the fence farthest from me; but after flying ten or fifteen yards he suddenly doubled, keeping near the ground, and going so rapidly that the closest attention was necessary to follow him. As soon as he lit, I started him off again, when he repeated the same dextrous maneuver, but with the addition of another double or two. He permitted three or four experiments of this kind before he realized that he was favoring me with too generous a free-exhibition, and left. The performance reminds one of the similar and usual stratagem of a hunted rabbit. The voice of the little fellow is quite ventriloquous—seeming to come from a point much nearer than it really does. They lie close until nearly stepped on, and then flit out of the weeds and into them again in a most vacillating manner, as though trying to dodge an expected gunshot; and when they light, they run so far and so fast that it is difficult to get them up again. (L.R.F.)

Zonotrichia leucophrys, Sw. *White-crowned Sparrow.*—May 11, 1878. Numbers seen and taken on December 28, 1878.

Zonotrichia albicollis, Bp. *White-throated Sparrow.*—May 11, 1878. Remains very common into the first of May.

Junco hyemalis, Scl. *Black Snow-bird.*—October 13, 1878.

Melospiza palustris, Bd. *Swamp Sparrow.*—October 26, 1878.

Cyanospiza cyanea, Bd. *Indigo Bird.*—April 22, 1878.

Pipilo erythropthalmus, V. *To-whee Finch.*—A nest taken in May, 1875, contained 3 eggs. This nest was pointed out to me by some woodchoppers working in the vicinity. In two weeks my attention was again called to the same pair of birds, they having constructed another nest this time in the top of a mulberry tree, 20 feet from the ground. (C.D.)

Icterus spurius, Bp. *Orchard Oriole.*—April 27, 1879.

Tyrannus carolinensis, Bd. *Kingbird.*—April 27, 1879.

Empidonax minimus, Bd. *Least Flycatcher.*—August 27, 1879.

Coccygus erythropthalmus, Bp. *Black-billed Cuckoo.*—Nest and eggs taken. Nest was placed on top of some blackberry bushes.

Nyctale acadica, Bp. *Saw-whet Owl.*—November 17, 1878 ; May.

Squatarola helvetica, Brehm. *Black-bellied Plover.*—September 21, 1879, male.

Ægialitis semipalmatus, Cab. *Semipalmated Plover.*—September 15, 1878, several specimens.

Tringa bairdii, Coues. *Baird's Sandpiper.*—October 27, 1878.

Calidris arenaria, Ill. *Sanderling.*—September 15, 1878.

Nyctiardea grisea nævia, Allen. *American Night Heron.*—October 2, 1879.

Ardetta exilis, Gray. *Least Bittern.*—September 2, 1879.

Porzana carolina, Cab. *Sora Rail.*—November 2, 1878.

Mergus serrator, Linn. *Red-breasted Merganser.*—March 24 and April, 1879.

Sterna hirundo, Linn. *Wilson's Tern.*—September 9, 1878.

Sterna forsteri, Nutt. *Forster's Tern.*—May 4, 1879, six specimens.

Hydrochelidon lariformis, Coues. *Black Tern.*—August 17, 1879; September 15, 1878, nine specimens.

DESCRIPTION OF TWELVE NEW FOSSIL SPECIES, AND REMARKS UPON OTHERS.

By S. A. Miller, Esq.

Holocystites tumidus, n. sp.

Plate IX., fig. 1, posterior view of the lower part of the body.
fig. 1*a*, anterior view of the lower part of the body.

This species is founded upon a single specimen, showing the lower part of the body. The point for the columnar attachment appears rudimentary or like a nipple, and not as if the column had been broken off. The pores, which are so numerous in the plates of this species, extend to this protuberance, and perforate it in numerous places, which tends to show its rudimentary character, as we would not expect to find the perforations in a column. The inference is that it may have had a column in its young state, for attachment to some other object, and in maturity was free, preserving only the rudimentary organ.

The body expands very rapidly upon the dorsal or posterior side, and but little upon the ventral or anterior side.

The first range of plates extends a little less than half way around the base of the rudimentary column on the anterior side. This range contains about a half dozen small irregular plates.

The second range is on the anterior side, and extends about two thirds of the distance around the base of the rudimentary column. It contains twelve irregularly pentagonal plates of somewhat uniform size.

The third range encircles the base of the body, and consists of eighteen plates. These are very unequal in size, but all of them are hexagonal except three upon the posterior side, which are pentagonal. Only five plates, in this range, abut upon the base of the rudimentary column.

The fourth range contains nineteen plates. These are unequal in size and irregular in shape. They are pentagonal, hexagonal and heptagonal.

The fifth range consists of twenty-five plates, varying in form from pentagonal to octagonal.

The sixth range consists of about the same number of plates. The average size, however, being slightly increased. Only a part of the seventh and eighth ranges are preserved.

All the plates are very poriferous.

This species was collected by Fred. Braun, Esq., in the lower part of the Niagara Group, in Ripley county, Indiana, though the specimen illustrated is in my collection.

Holocystites baculus, n. sp.

Plate X., fig. 5, view of the left or ambulacral side.
fig. 5*a*, view of the summit.

Body long, slender, subcylindrical and very gradually tapering in the lower third to the column. The summit is prolonged, in the direction of the ambulacral orifice, which is situated on the left side. The prolongation is much more marked than in *H. perlongus.* This orifice is subquadrangular and surrounded by five arms. The small plates surrounding the orifice are not clearly determinable in our specimen. The next range which assists in the support of the arms, consists of eight plates. Five of these are hexagonal; two of them extend to the mouth, on each side of the anal plate, and may therefore be called heptagonal, as this adds a mouth-side to them; and the eighth or anal plate, which is a long pentagonal plate, between the two latter, and extending from the mouth to the smaller plates surrounding the ambulacral orifice. It possesses a small anal aperture

situated in a line drawn across the exterior part of the adjoining arm bases.

The third range of plates, descending from the ambulacral orifice, consists of eight plates and embraces the mouth. Six of these are heptagonal, the seventh side being produced by the intercalation of small plates, between alternate plates, on the ambulacral side of this range and the next full range of plates below. The plate upon the left of the mouth, including the mouth-side, is pentagonal, and the plate upon the right of the mouth, including the mouth-side, is hexagonal. I have not included in this range the plate upon the lower side of the mouth. The mouth is thus placed close to the anterior side, and in the third range of plates in descending order. Part of the plates surrounding the mouth are removed in our specimen, but the scar shows the elliptical outline of the mouth.

The fourth range may be called an imperfect range, because it is separated on the ambulacral side, and includes only the alternate intercalated plates. The rapid expansion, however, of the body upon the right and posterior sides, and the smaller size of the plates gives us twelve plates in this range: ten of them are joined together, and two of them are the separated intercalated plates upon the ambulacral side. One of the plates abuts upon the lower side of the mouth.

The fifth range is injured in our specimen, so that it is a matter of some doubt, whether it consists of eight or nine plates, but the indeterminable space is only the width of one of the other plates, and, therefore, we conclude, it consists of eight plates. This range is well nigh broken in the posterior part of the ambulacral side, where two plates unite only at an angle instead of by their sides.

The sixth range is composed of about twice as many plates, as ten plates shown, in our specimen, abut upon five in the fifth range. Only part of the seventh, eighth, ninth and tenth ranges are preserved, in the specimen illustrated; enough, however, to show that the plates are of unequal size and not regularly disposed into ranges. Another specimen shows, that, at about the tenth or eleventh range, the body begins to taper for the column below, but we are not able to describe the plates upon this part of the body.

The surface of the plates is pustulated, and numerous pores penetrate the body through these pustule-like prominences, but between them the plates appear to be barren of pores.

This species was collected by Fred. Braun, Esq., and the author, near the base of the Niagara Group, in Ripley county, Indiana; the specimens described, however, are in my collection.

Holocystites rotundus, n. sp.

Plate IX., fig. 3, summit view, natural size.
fig. 3*a*, view of the right side, natural size.
fig. 3*b*, basal view, natural size.

Body spheroidal, swelling most upon the left side, supported upon a column, and covered by about six ranges of plates. There are about seven or eight basal plates, and from twelve to fourteen plates in each of the succeeding four ranges. The sixth range is too much involved among the apertures, on the summit, to determine from our specimens the number of plates.

The ambulacral orifice is situated centrally, upon the apex of the summit, posterior to the mouth. It is subelliptical in outline, and surrounded by four small arm bases. We can not determine, from our specimens, the number of plates that abut upon this orifice.

The mouth is situated sub-centrally, and directly anterior to the ambulacral orifice. It is sub-circular in outline. An anal aperture is observable, between these two larger openings, in the plate, which abuts upon the mouth, and it is situated a little nearer to the mouth than to the ambulacral orifice.

Upon the summit of this species, there are a number of conical depressions, irregularly distributed, none of which penetrate the plates, so far as observed, and some of them evidently do not. On the specimen illustrated there are twenty-two of these conical depressions, and on another specimen of the same species, there are only twelve. No function can be ascribed to them.

Some of the plates, upon the summit, are possessed of peculiar elongated pores on the outer surface, but no pores have been observed on the other plates, though they probably exist.

This species was collected by Prof. A. G. Wetherby, to whose collection the type belongs, near the base of the Niagara Group, in Ripley county, Indiana.

Holocystites subrotundus, n. sp.

Plate IX., fig. 2, basal view, natural size.
fig. 2*a*, summit view, only part of the plates preserved.

Body subrotund, and possessed of a column. Plates generally large. The first range of plates at the point of columnar attachment too much anchylosed, in our specimens, for accurate determination.

The next three ranges are each possessed of thirteen plates. Those covering the ventricose or posterior side of the specimen very large. A plate, in the fourth range, forms part of an arm support, hence the

body may be said to be covered by four ranges of plates, with the exception of some irregular plates, which may be found at the base, and those surrounding the mouth, and those within the area surrounded by the arm bases.

The plates are generally pentagonal or hexagonal, but on the anterior side they do not come regularly together, in each range, and a plate in the second range abuts against three plates in the third range. instead of two, which produces, at this place, heptagonal plates.

The only arm known rested upon two plates, supported by a third, as shown by the base. The mouth and ambulacral orifice unknown. All the plates are perforated by numerous elongated pores.

This species was collected by Prof. A. G. Wetherby, in the lower part of the Niagara Group, in Ripley county, Indiana. The specimen illustrated belongs to his collection.

Holocystites dyeri, n. sp.

Plate X., fig. 3, view of the right side.

Body very large, and somewhat obovate, in form. It is covered by about twelve or thirteen irregularly disposed ranges of plates.

The first range, above the basal plates, consists of fifteen plates. The second range has one or two more. The number increases in the third, fourth, fifth, sixth and seventh ranges, though the plates are so irregularly disposed that it is hardly proper to speak of them as ranges. In the most ventricose part of the body, a range, if regularly disposed, would consist of about twenty-five plates. The plates are of unequal size, usually hexagonal or pentagonal, but sometimes heptagonal or octagonal. They are more or less convex and highly poriferous. The pores are elongated upon the outer surface, and distributed without apparent order or arrangement.

The summit of our specimens is so much injured, that it shows only one of the arm bases, and consequently we can not define the apertures. The species, however, is readily distinguished by its large size and obovate form.

The specimen has a length of three inches; diameter at the base, 67-100ths inch; diameter of the most ventricose part, 2 33-100ths inches.

The specimen described was found by C. B. Dyer, Esq., in whose honor it is named, in the lower part of the Niagara Group, in Ripley county, Indiana.

Holocystites ventricosus, n. sp.

Plate X., fig. 4, view of left side of ventricose part.

This species is founded upon a single specimen, which is broken off

both at the upper and lower ends. It is three inches in length, and has a diameter of 1 1-10th inches, where it is broken off at the lower end, and 1 9-10ths inches at the upper end. The greatest diameter of the most ventricose part is 2 2-10ths inches. From the appearance of the specimen we infer that ½ inch would reach the summit, at the upper end, and that 1½ inches would reach the column, at the lower end. This addition would make a complete specimen, about five inches in length. The body would, therefore, be described as very long, gradually enlarging from below, and ventricose in the upper half.

The body is covered by plates of unequal size and irregular form. They vary from a pentagon to a nonagon, and from a diameter of 1-10th to a diameter of 6-10ths inch.

In the three inches in length of the specimen illustrated, if the plates were regularly disposed, there would be about ten ranges.

The plates are all more or less convex, and perforated by numerous pores.

I collected this specimen in the lower part of the Niagara Group in Ripley county, Indiana.

I have now described fourteen species of Holocystites, from the lower part of the Niagara Group of Indiana, and have been unable to identify a single species, with those found in the Niagara Group of Illinois and Wisconsin. Fragments of other species have been found, in Indiana, but those, which I have seen, are not in a condition to be defined.

Anomalocrinus caponiformis (Lyon).

Plate IX., fig. 4, basal view.
fig. 4*a*, view of the summit.

The body below the arms is almost flat, except as to the curving up on the azygos side; and the entire height of the body, from the junction with the column, to the top of the plates preserved on the dome is only a little over one third of the width of the body, and is less than the width of either one of the arm-bearing radial plates.

The five basal plates, when united, form a large pentagonal figure.

The first radial on the right of the azygos side, is much the largest plate of the body. Two sides rest upon two basal plates; one side joins the first azygos radial; one joins the second azygos radial; one supports the single azygos inter-radial; one joins the posterior first radial, and another the posterior second radial. These seven sides by no means bound the plate, for it curves over upon the vault, and a wide cleft or yoke-like opening extends from the plates covering the dome, to the center of the plate, where the free arm plates rest.

The first radial on the left of the azygos side rests upon two basal plates, and joins the first and second azygos radials upon the right and the second, first radial upon the left, and curves over on the vault, and is widely cleft to the center where the free arm plates rest.

The second first radial on the left of the azygos side rests upon two basal plates, joins the first radial upon the left of the azygos side, and the first and second posterior radials, and curves over on the vault, and is widely cleft to the center, where the free arm plates rest.

The posterior first radial rests upon two basal plates, joins the right anterior first radial and the second, first radial on the left of the azygos side, and supports upon its long arcuate upper side the second radial.

The posterior second radial rests upon the posterior first radial, joins one side to the right anterior first radial, and another to the second first radial on the left of the azygos side, curves over upon the vault, and is widely cleft to the center, where the free arm plates rest.

The first azygos radial is a little smaller than the posterior first radial, and rests upon two basal plates, joins the left and the right anterior first radials, and supports upon the upper side the azygos second radial.

The azygos second radial rests its longer side upon the first azygos radial; upon its left side it joins the left anterior first radial and curves over upon the vault; upon its right side it joins the right anterior first radial and supports the azygos interradial plate. It is also cleft for the support of the free arm plates, but the interradial plate forms one side of the yoke-like opening, from the free arm plates to the smaller plates covering the dome.

The single interradial plate rests between the right anterior first radial and the azygos second radial, and articulates with these plates upon a serrated edge. It rises higher than the plates preserved in our specimen, and curves toward the left anterior plate, while three plates of the dome, in the direction to which its curvature points, stand upon edge, showing quite clearly that the dome was possessed of a sub-central proboscis on the azygos side.

The plates covering the outer rim of the dome, commencing at the three preserved plates of the base of the proboscis, on the left of the azygos side, and extending around to the azygos interradial, are preserved in our specimen. The preserved plates, in this rim, form a row from three to five wide, and show the dome very gradually arching toward the proboscis. They are irregular and unequal in size, the largest being about 1-8th of an inch in diameter.

The yoke-like cleft of each radial plate, from the base of the arm to

the plates of the dome, is covered by an arch composed of minute plates. The length of an arch is about 4½ lines, width 3 lines, and elevation 1½ lines. This arch, extending from the dome to the furrow upon the inner side of the arm (if not farther), is a striking peculiarity.

The specimen illustrated and described was found in the Hudson River Group, at Cincinnati, and is from the collection of C. B. Dyer, Esq.

This species was described and illustrated, by Sidney S. Lyon, in 1869, in the Trans. Am. Phil. Soc., vol. 13, under the name of *Ataxocrinus caponiformis.* His specimen was somewhat crushed, and hence his illustrations do not show several peculiarities, which are presented, in our illustrations.

In the proceedings of the Acad. Nat. Sci. Phil., in 1865, Meek and Worthen proposed the name *Anomalocrinus* as a subgenus, but did not clearly define the generic characters. In the Illinois Geo. Sur., vol. 3, in 1868, however, they more particularly described the subgenus, and illustrated the species, *A. incurvus.* The diagrammatical showing of the structure is very erroneous, which may have misled Prof. Lyon, but the description is sufficiently clear to give *Anomalocrinus* priority over *Ataxocrinus.*

In 1873 (Geo. Sur. of Ohio, pt. 2, Palæontology), Prof. Meek redescribed the *Anomalocrinus incurvus*, and illustrated it from a specimen in my collection, and took the position, that *Ataxocrinus caponiformis* is the same crinoid, and therefore a synonym. I followed him, in classing the latter as a synonym, in the "American Palæozoic Fossils," in 1877. But this was, certainly, error, and I am glad that I have the opportunity of restoring the name *caponiformis*, to a species, so distinct, from *incurvus*, if we regard the specimen illustrated, in the Ohio Palæontology, as a type.

Let us look at some of the differences. The *incurvus* has six basal plates, the sixth plate being quadrangular and below the right anterior first radial. This radial rests upon three basal pieces instead of two. This is an essential difference, but we need not stop here, for the general form of the body and proportion of the plates are very different in the two species: The body of the *caponiformis* forms a broad almost flat disk, while the *incurvus* has a moderately deep cup and expands on the azygos side, only about a line beyond the perpendicular, with the column. The measurements of the two specimens are as follows:*

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* In this measurement I follow Meek in calling the azygos side the posterior side, in order to make the comparison with his measurement clear, though in the description the azygos side is treated as the anterior side.

A. incurvus — Height of body, on the posterior side, 0.67 inch, and on the anterior 0.43 inch; greatest breadth 0.92 inch; thickness of column at its connection with the body 0.34 inch.

A. caponiformis.—Height of body, on the posterior side, 0.67 inch, and on the anterior 0.35 inch; greatest breadth 1.65 inches; thickness of column at its connection with the body 0.34 inch.

The width of the right anterior first radial in *A. caponiformis* is 9-10ths inch, in *A. incurvus* it is 5-10ths inch, while the height of the former is 36-100ths, and the latter 28-100ths. Other plates show the same difference between the relative proportions of width and height in the two species.

The five basal plates in *A. caponiformis* form a pentagon of almost equal sides, while the six basal plates in *A. incurvus*, form arcuate faces to a sub-pentagonal figure. The cup of the latter is subangular in the direction of the arms, a feature not possessed by the former. These and many other minor differences may be pointed out.

I know of no species among the palæozoic crinoids, which is held to include forms so distinct as these, while subgenera are formed upon peculiarities of much less importance.

A word ought, perhaps, to be said upon the question, whether the specimen described and illustrated, in the Ohio Palæontology, is specifically the same as the one described in the Illinois Geo. Sur., upon which the *Anomalocrinus incurvus* was established. I have before said, that the diagrammatical structure, in the Ill. Geo. Sur. is erroneous, and where such a poor representation is made, we may fairly attribute it to the imperfection of the specimen. The specimen may have possessed six basal plates and yet only shown five, on account of the imperfect preservation or the anchylosing of the plates. The general outline of the specimen as represented on the plate, is the same as that represented in the Ohio Palæontology. I, therefore, conclude, that the specimens represented in the Illinois and Ohio Surveys both belong to *Anomalocrinus incurvus*.

I may add that the specimen of *Anomalocrinus caponiformis*, here illustrated and defined, is the only one I have ever seen, and it is, therefore, extremely rare. It is quite true, too, that *Anomalocrinus incurvus* is very rare, and that but few collectors have a moderately good specimen of it.

TRICHOPHYCUS VENOSUM, n. sp.

Plate IX., fig. 5, showing diagonal lines, natural size.
fig. 5*a*, showing the irregularity of the elevated lines, natural size.

This plant, as known to me, consists of a half cylindrical stem.

covered upon the cylindrical surface with irregular and inconstant elevated lines, varying in their course from longitudinal with the stem, to diagonally radiating from a central line.

If the stem was originally cylindrical, one half of it seems to have been invariably destroyed in the rock, so as to leave a flat under surface.

The greater diameter is generally about an inch. No bifurcation has been observed.

Collected in the Hudson River Group at Cincinnati. The specimens illustrated are from my own collection, but specimens equally distinct are in the hands of other collectors. It is not common, but it is more abundant than either *T. lanosum* or *T. sulcatum.*

Pisocrinus gemmiformis, n. sp.

Plate IX., fig. 6, basal view, natural size.
fig. 6*a*. basal view, magnified two diameters. pt
fig. 6*b*, side view, showing the hexagonal plate of the calyx.
fig. 6*c*, magnified side view, showing the hexagonal plate of the calyx.

The body is small, round, smooth, and possessed of a deep circular cavity, at the base, for the reception of the columnar attachment, which somewhat resembles a bell-mouth.

The five basal plates united, form a triangle almost equilateral. The three plates, in the angles of this triangle, have, each four sides; the other two plates have three sides each. The two plates, in the angles of the triangular figure, which are not separated, by a triangular plate. are the larger plates, and of equal size. The two triangular plates are the smaller plates and of equal size. In thus describing the plates, I have treated them, as if they each presented an angular point, at the union, with the central part of the column; but this is not strictly true, for a small foramen connects the body, with the central opening of the column, and each plate abuts upon this foramen, which gives to each plate an additional side, though a very minute one.

The five basal plates are succeeded, by three comparatively large plates, which form the principal part of the calyx. Two of these plates are radials, the third is separated from the arms by two small intervening plates. One of these large radials is supported, upon two basal plates; unites two sides, with the adjoining plates of the calyx; supports upon two upper sloping sides, two of the smaller radials; and upon its upper face an arm; making an heptagonal plate. The other large radial has the same form, except that it is supported, upon three basal plates, and is therefore octagonal. The third plate, forming the calyx, is supported, upon three basal plates; unites two sides, with the adjoining plates of the calyx; and supports upon its two

upper sloping sides two of the smaller radials; it, is, therefore, an hex- pt agonal plate, much wider than long.

Two of the smaller radial plates unite over the middle part of the hexagonal plate, upon which, they rest their longer arcuate sides. The other inferior side of each is much shorter, and rests in a little arcuate notch, in the superior part of the adjoining larger radial. The other smaller radial plate is supported between the two larger radials, by a small arcuate side, in the superior part of each.

The species as may be seen from the foregoing description has five arms, three of which are supported upon the smaller radials, and the other two by the larger radials. Our specimens do not preserve the arms, but the arm bases are comparatively large, for such small specimens, and show that the arms must have been crowded close together. One of the arm plates possesses a very wide and deep ambulacral furrow, for so small a plate. The column is small and round.

This is the first species described, in America, that has been referred to the genus, *Pisocrinus*, of M. de Koninck. It is distinguished from the European species by the shape of the plates. In the European species, two of the basal plates unite in an angle of the triangular figure formed by the basal plates, and, therefore, only one side of the triangle is formed by the sides of three basal plates. The other two sides, being each formed, by two sides of the basal plates. In our species, two of the sides of the triangle, formed by the basal plates, are each made by the sides of three basal plates, and only one by the sides of two basal plates. In the European species, the large plate, occupt pying the position of the hexagonal plate, in our species, is pentagonal. It rests upon two basal plates, while, in our species, it rests upon three. The arm bases are also quite distinct, in their shape; but as our species falls into the generic formula of *Pisocrinus*, we regard these distinctions as of only specific importance. Moreover the genus *Pisocrinus* is only known, in Europe, in rocks of upper silurian age.

This species was collected by the ardent and indefatigable palæontologist, Fred. Braun, Esq., and by the author, in the lower part of the Niagara Group, in Ripley county, Indiana; the specimens illustrated, however, are from my collection.

MEGISTOCRINUS PILEATUS, n. sp.

Plate X., fig. 1, diagrammatical view from a flattened specimen.
fig. 1*a*, summit view.
fig. 1*b*, basal view.

The body is deeply depressed, for the columnar attachment; subcircular at the arms, being slightly elongated from the anterior to the posterior side; and convex on the dome.

The illustrated flattened specimen shows the basal plates united, forming a hexagon. The six first radials are hexagonal, wider than high, lower and upper margins parallel, and the lower a little longer than the upper. Four of the second radials are hexagonal and the other two appear to be pentagonal, one of them is certainly pentagonal. Five of them are wider than high, while one pentagonal plate is higher than wide. Five of the third radials are represented, each of which is pentagonal, and supports, upon its upper sloping sides, two secondary radials. Beyond this, we can only trace part of the plates, which are supported by two of the radial series, and if the pentagonal second radial is upon the azygos side, then we have the posterior radial series, and the right posterior radial series. The first secondary radials in these series are heptagonal, except the one, upon the right of the right posterior series, which seems to be hexagonal. The second secondary radials are hexagonal, and as far as can be observed appear, each, to support three radial series. This would give to a specimen, if there was no irregularity, thirty arms. But we find the arms, thrown, in clusters of three, only part of the way around the body, the arrangement being disturbed, upon the azygos side; the actual number of arms is only twenty-seven.

Four of the first interradials are hexagonal, the other two are heptagonal, and join the pentagonal second radials. The first interradials are each succeeded by two second interradials, and these by three third interradials. Above the third series of interradials, smaller plates fill the space, between the secondary radials.

The first and second radials and the first interradials are within the columnar depression, and are either flat or slightly convex. The third radials, the first secondary radials and the second and third interradials are strongly tuberculated, or rise into little cones and form a rim midway between the column and the arms, from which the plates ascend, upon one side to the arms, and upon the other, up into the columnar depression. From this rim to the arms, the plates are either highly convex or conical. The illustration of the basal view of a specimen, in which the plates are firmly anchylosed, is intended to show this rim and the conical plates. The part of the column preserved in this specimen is no doubt pushed to one side of its natural position.

The arms are unknown. except at the point of attachment to the body. There are twenty-seven, as above mentioned.

The dome is quite convex, and covered by a great number of small convex plates, of unequal size and irregular form. A plate upon the apex of the dome is a little larger than the others, and is surrounded by about twelve small plates, but no order of arrangement of the plates

seems to prevail over the dome. The base of a proboscis is shown, in the anterior third of the dome. The dome is also possessed of five spinous plates. One of these is on the posterior part, behind the proboscis; one on each side of the proboscis, a little more than half way to the arm bases; and one behind each of the latter, near the arm bases, and a little anterior to the posterior spine, first above mentioned.

The column is round, of medium size, composed of alternately thicker and thinner plates, the thicker projecting beyond the thinner ones, and the articulating faces furrowed by radiating lines. The pentagonal opening is rather large.

This species was collected by Prof. W. H. Colvin and the author, in the Upper Helderberg or Corniferous limestone, at the stone quarries near Columbus, Ohio. The specimens illustrated are in my collection. The specific name is from the cap-like form of the body.

Stephanocrinus osgoodensis, n. sp.

Plate X., fig. 7, natural size.
fig. 7*a*, magnified two diameters.

Body small, obconoidal, triangular at the base, or rather hexagonal, because three very obtuse angles are formed, at the junction of the plates, and slightly pentagonal above.

The basal plates are longer than wide, and united, leave a small depression, at the base, for the columnar attachment. Each plate is sharply angular, in the middle of the lower half, but the angle fades away, in the upper half. An obtuse angle is formed, at the junction of the plates, in the lower half, which also fades away, in the upper half. The three basal plates, therefore, form an hexagonal outline, in the lower half, marked by three sharp angles in the middle of the plates, and three obtuse angles, at the sutures. These angles fade away in the upper half, and are not continued on the radials. Two of the basal plates are hexagonal, having each three upper sides, and are of equal size. The other plate is smaller, in the upper half, and having only two upper sides, is pentagonal.

The five radial plates form obtuse angles, at the sutures, but the plates are a little convex, which well nigh destroys the pentagonal appearance of the body. These plates are a little longer than wide, three of them are heptagonal and two hexagonal. The heptagonal plates have two lower sides, each of which is supported, upon a basal plate, while the hexagonal plates have only one lower side resting upon a basal plate. The upper margin of each plate is deeply excavated, for the reception of the pseudo-ambulacral structure.

The plates of the third range are very small, if they exist at all. The

junction of the radials is very distinct, in our specimens, two thirds of the distance, from the base of the pseudo-ambulacral structure, to the highest extension of the plates, and the line of separation apparently extends to the point. If there is, therefore, a plate capping each of these points of extension, it is minute. This extension of the plates is distinctly angular, in the middle, at the line of the junction of the plates.

No part of the ambulacral or pseudo-ambulacral structure is known.

Prof. Hall has suggested, that there is no generic distinction, between *Codaster* and *Stephanocrinus*. This being the case, *Stephanocrinus* has priority over *Codaster*, unless Conrad's genus is to be condemned for imperfect definition and illustration.

This species was collected in the lower part of the Niagara Group, at Osgood, Indiana. The specimen illustrated is from my collection.

PALÆASTER HARRISI, n. sp.

Plate X., fig. 2, natural size.
fig. 2*a*, magnified two diameters.

Body pentagonal; rays twice as long as the diameter of the central part of the body, flexuous, and quite uniformly tapering, to acute points, at the apices.

The ambulacral furrows are very narrow.

The adambulacral plates are like small, flattened, sub-circular, indented disks, arranged with their flattened and indented faces in contact. They diminish, in size, very gradually, from the body, toward the points of the rays, and number from twenty-five to thirty, on each side of the ambulacral furrows.

There are ten oral plates, at the junction of the adambulacral series, each one of which has a somewhat triangular outline, and extends the most acute angle, toward the central part of the body.

This species is destitute of the marginal plates, which usually characterize the species of this genus, and seem to protect and strengthen the adambulacral plates, and thereby protect the extension of the animal, in the ambulacral furrows.

The ray which is broken off, at the distance of seven adambulacral plates, from the oral plates, shows two plates forming the bottom of the ambulacral furrow, and that the ray, at this distance from the body, is covered, by five series of dorsal plates.

The first dorsal series, upon each side of the rays, consists of subcircular plates, each of which is possessed of a sharp central spine. These plates cover, upon the outside, the line of junction, between the adambulacral plates and the two series of plates, which form the bottom

of the ambulacral furrow, and extend over, upon the plates, in the bottom of the ambulacral furrow, and up, on the sides of the adambulacral plates. The protection established, by this arrangement, and that afforded, by the spines, seems, in this species, to have removed the necessity, for the usual marginal plates.

This species is founded, upon a single specimen, embedded in a slab. The madreporiform tubercle, the other plates of the dorsal side, ambulacral ossicles, and other parts, unknown.

This unique specimen was found, in the upper part of the Hudson River Group, near Waynesville, Ohio, and is from the magnificent collection of I. H. Harris, Esq., of Waynesville, in whose honor, I take great pleasure, in proposing the specific name.

LICHENOCRINUS PATTERSONI, n. sp.

Plate X., fig. 6, natural size.
fig. 6*a*, magnified two diameters.

Body robust, round or sub-circular, plano-convex, with a depression around the column, composed of numerous plates of unequal size, having no regular geometrical form, and disposed without any definite order of arrangement. If the plates, in the specimen illustrated, could be arranged, in regular concentric series, there would be, about eighteen ranges, between the column and the circumference.

The plates are smooth.

The column-like appendage is large, round and composed, as in other species, of five ranges of thin plates.

The plates, in this species, are as large as the plates in *L. crateriformis*, and as numerous as in *L. dyeri*, but they have neither the arrangement nor form of either.

Mr. W. J. Patterson, an energetic and successful collector, in whose honor I have proposed the specific name, found the specimen illustrated, on the Kentucky shore, opposite the foot of Fifth street, Cincinnati. If it belonged to the rocks exposed, at that place, it would be of the age of the Utica Slate, but if it was drifted, it may be of the age of the Hudson River Group. The small piece of limestone, upon which it rests, is water worn, and furnishes no evidence to assist us in determining the age. The only reason I have, for thinking, that it may be of the age of the Hudson River Group is, that a few years ago, I found a fragment of the same, or asimilar species, in the upper part of the Hudson River Group, near Versailles, Indiana. All we can say, therefore, of its age, is, that it was found with rocks of the age of the Utica Slate, but under such circumstances, that it may have been transported there, from rocks of the age of the Hudson River Group.

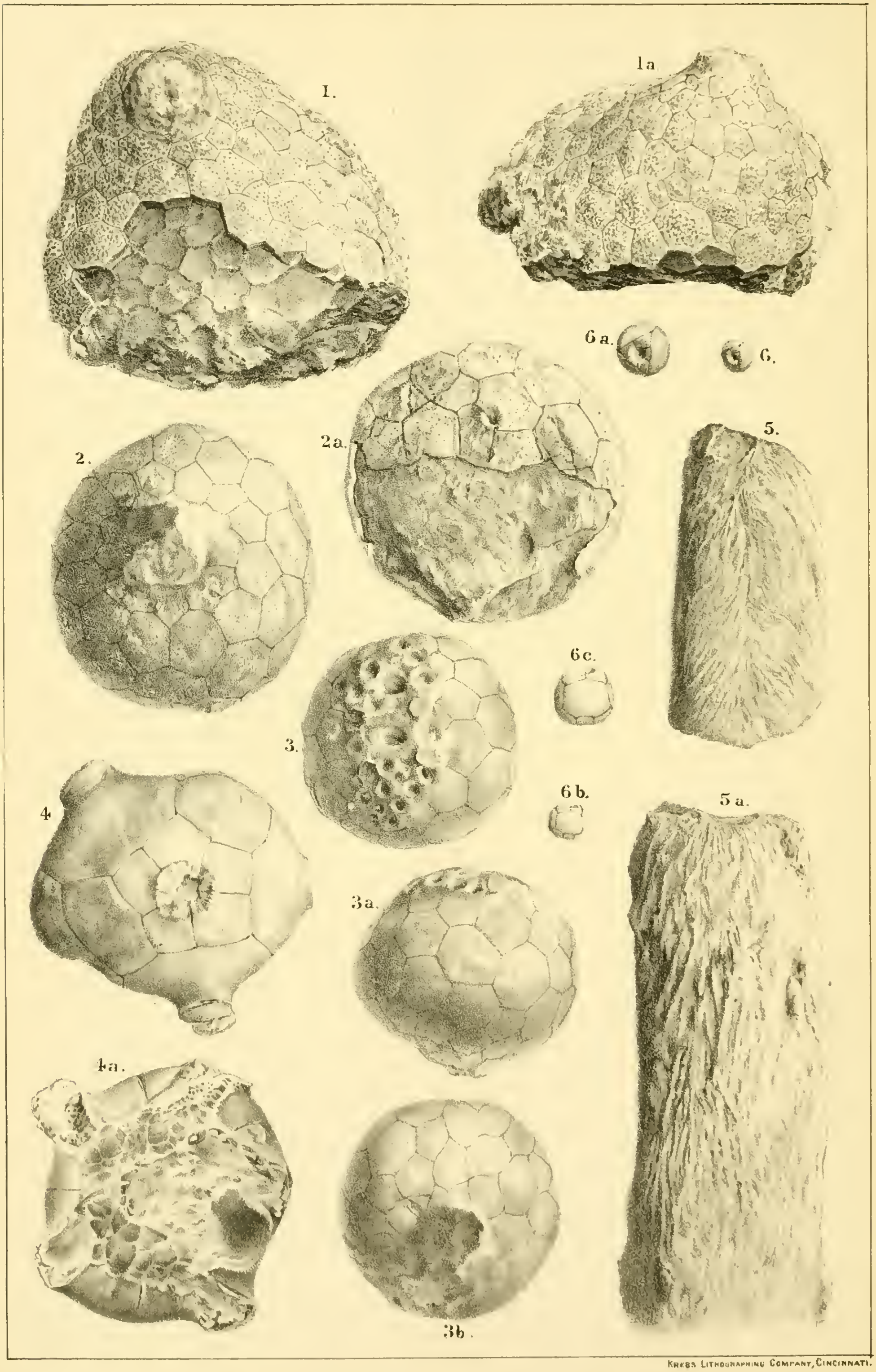

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PLATE IX.

Fig. 1. HOLOCYSTITES TUMIDUS—Posterior view of the lower part of the body. Natural size.

1a. Anterior view of same specimen.

Fig. 2. HOLOCYSTITES SUBROTUNDUS—Basal view. Natural size.

2a. Summit view of same specimen—only part of the plates preserved.

Fig. 3. HOLOCYSTITES ROTUNDUS—Summit view. Natural size.

3a. View of the right side. Natural size.

3b. Basal view. Natural size.

Fig. 4. ANOMALOCRINUS CAPONIFORMIS—Basal view. Natural size.

4a. View of the summit of the same specimen.

Fig. 5. TRICHOPHYCUS VENOSUM—Showing diagonal lines. Natural size.

5a. Showing the irregularity of the elevated lines. Natural size.

Fig. 6. PISOCRINUS GEMMIFORMIS—Basal view. Natural size.

6a. Basal view, magnified two diameters.

6b. Side view, showing the hexagonal plate of the calyx.

6c. Magnified side view, showing the hexagonal plate of the calyx.

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PLATE X.

Fig. 1. Megistocrinus pileatus—Diagrammatical view, from a flattened specimen.

1a. Summit view.

1b. Basal view.

Fig. 2. Palæaster harrisi—Natural size.

2a. Magnified two diameters.

Fig. 3. Holocystites dyeri—View of the right side. Natural size.

Fig. 4. Holocystites ventricosus—View of left side of ventricose part. Natural size.

Fig. 5. Holocystites baculus—View of the left or ambulaeral side. Natural size.

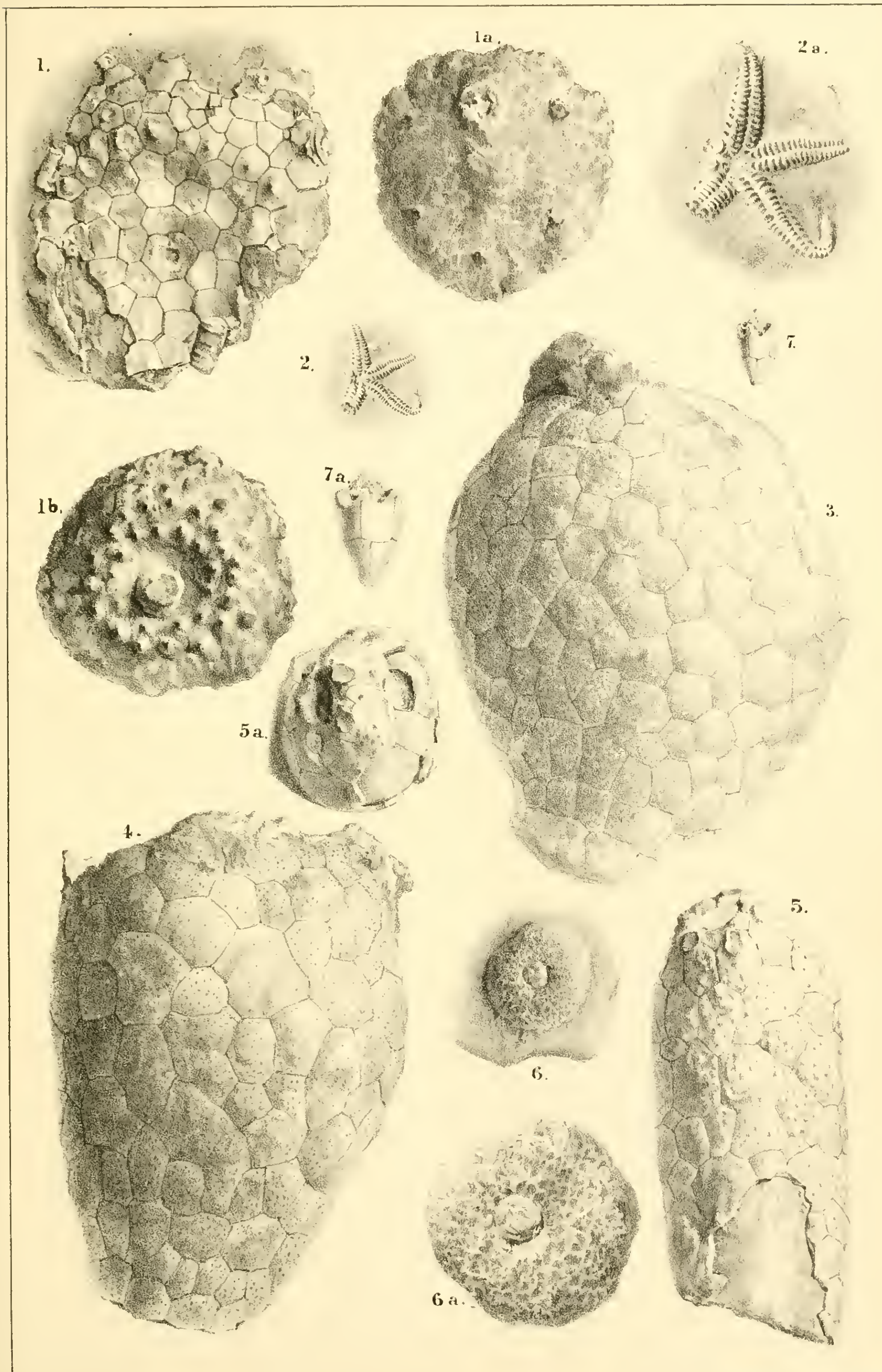
5a. View of the summit of the same specimen.

Fig. 6. Lichenocrinus pattersoni—Natural size.

6a. Magnified two diameters.

Fig. 7. Stephanocrinus osgoodensis—Natural size.

7a. Magnified two diameters.



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DESCRIPTION OF A NEW GENUS AND SOME NEW SPECIES OF BRYOZOANS FROM THE CINCINNATI GROUP.

By E. O. Ulrich.

The following generic name is proposed for the reception of a number of species, that at first were considered to be aberrant forms of *Chætetes* or *Monticulipora*. A more thorough examination, however, showing the constant occurrence of certain characteristics, has led me to the conclusion that the characters developed in the species are of sufficient importance to sanction their separation from those genera under a distinct generic title. The genus may be characterized as follows :

Atactopora, nov. gen.

[Ety.—*Atactos*, without regularity.]

Bryozoary variable in shape, incrusting, sub-ramose or truly ramose. composed of numerous closely approximated tubes, the walls of which are imperforate. Tubes supplied with pseudo-septa, which in some species are visible at the surface, and in others not. Pseudo-septa very irregular in size, number, and arrangement, probably numbering never more that five or six in a single tube. Diaphragms, when present, complete. Interstitial tubuli rather sparingly developed. Surface

usually raised into monticules that may be composed either of densely cellulose tissue, or of slightly larger or smaller tubes than those of the average size.

Type: *A. hirsuta.*

From the forms usually classed under *Monticulipora*, species of this genus are principally distinguished by the pseudo-septa, which are developed only at rare intervals in some of the species of that genus. Of the described species, *Chætetes ortoni*, Nicholson, is the only one known to me to possess the characters of *Atactopora*. All the other species referred to the genus, I believe to be new to science, and I have so described them.

Atactopora hirsuta, n. sp. (Plate XII., figs. 3, 3*a*, 3*b*.)

[Ety.—*Hirsutus*, rough, spinous.]

Bryozoary growing parasitically attached upon foreign objects (usually coating an *Endoceras*), and forming very thin, sometimes much expanded crusts, not more than one half a line, and generally less than one fourth or one sixth of a line in thickness. Surface set with numerous, rounded or slightly elongated tubercles, having no distinct arrangement, and placed at distances apart of one line, more or less. Tubercles compact at their summits, the continuity of the compact portion frequently disturbed by the interpolation of calices of the ordinary size; the structure of the summits is minutely porous, though the pores usually can not be distinguished at the surface, and nearly the entire mass (of the tubercle) appears to be solid. Tubes somewhat oblique to the surface in very young specimens, and direct in older examples, thick-walled, nearly equal in size, apparently without any very minute interstitial tubuli. Tube calices small, elliptical to sub-rhomboidal, ten to twelve in the space of one line, their margins thick, and carrying two rows of minute tubercles, that are almost in contact and project over and into tube orifices, and are probably continuous with the small pseudo-septal ridges on the inner surface of the tubes.

Transverse sections prove the existence of the pseudo-septal ridges just mentioned. They are small, and number from three to four in each tube.

Atactopora ortoni, Nicholson, in many respects resembles this species, but the two can be readily distinguished by the differences existing in the surface tuberosities. In Prof. Nicholson's species the monticules are conical, smaller, more closely set, and are regularly ar-

ranged. *A. ortoni* grows in small, subcircular expansions, is almost invariably attached to the valves of *Strophomena alternata*, and does not to my knowledge occur in strata below three hundred feet above low water mark at Cincinnati; while *A. hirsuta* sometimes covers an *Endoceras* for the space of five inches or more, and has not been found above the two hundred feet line of strata. Other distinctions might be pointed out, but those mentioned are sufficient for the identification of the species.

Formation and locality: occurs rather rarely a few miles south of Covington, Ky., at an elevation corresponding to that of one hundred and fifty feet above low water mark in the Ohio river at Cincinnati, O.

Collectors: H. E. Dickhaut, E. O. Ulrich.

Atactopora maculata, n. sp. (Plate XII., figs. 2, 2*a*, 2*b*, 2*c*.)

[Ety.—*Maculatus*, spotted.]

Bryozoary parasitic, growing into expanded crusts, which vary in thickness from less than one quarter of a line to two lines; the usual thickness is about one half a line. All the specimens observed are attached to species of *Orthoceras* or *Endoceras*. Surface exhibiting rounded or elongated tuberosities, which are abruptly elevated, and from one fourth to one half a line in diameter, sometimes they are arranged in quite regular diagonal lines, but usually are irregularly distributed over the surface; measuring from their centers, the distance that they are apart varies from one to nearly two lines; summits of maculæ somewhat flattened and compact. Tube orifices sub-equal, moderately thin-walled, polygonal, about eight in the space of one line; interstitial tubuli few or entirely absent. Pseudo-septa well developed, though not often observable at the surface. Superior edges of tube walls, when well preserved, carrying a few small spines.

Transverse sections show the pseudo-septa very distinctly projecting into the tube area. They number from one to four or five, and are very irregularly distributed. In sections of this kind the maculæ present the appearance of clusters of minute tubuli, which undoubtedly is their true nature. In longitudinal section the tubes are usually without tabulæ, though these structures are not infrequently developed in moderate numbers. The maculæ appear minutely tubular, and are divided into distinct floors, that run parallel with the outline of the projection of the tuberosities on the surface. In a specimen one line in thickness, there are about five of these floors.

This is a common species, and, by collectors is frequently confounded

with the form to which Prof. Nicholson, in the Pal. vol. ii., Ohio Geol. Survey, gave the name of *Chætetes corticans*, which name he afterwards admitted to be synonymous with Edwards and Haime's older name, *C. tuberculatus*. The two forms can be distinguished by the following differences: In *C. tuberculatus* the colony is always very thin, the tubercles are decidedly elongated, are regularly arranged, carry calices of the ordinary size, and never, to any great extent, are compact. The tubes also are not provided with septa of any kind. The nature of the tubercles of *A. maculata* will serve to separate the species from any other species of the genus, excepting *A. hirsuta*. The numerous minute granules which cover the superior edges of the tube walls in the latter form, are sufficient to distinguish them.

Formation and locality: occurs at numerous localities in the lower three hundred feet of the Cincinnati Group, as exposed at Cincinnati, O.

Atactopora multigranosa, n. sp. (Plate XII., figs. 1, 1*a*, 1*b*.)

[Ety.—*Multi*, many; *granum*, a grain.]

A parasitic bryozoan, attached to species of *Orthoceras;* growing in large, thin expansions, frequently in superposed layers, and more developed in certain portions than in others; greatest thickness of any crust observed about three fourths of a line. Surface presenting numerous, irregularly distributed monticules, which sometimes have a portion of the summit compact, but usually the entire macula is composed of an aggregation of larger sized tubes than the average; the height and diameter of the tubercles vary, but their average dimensions are about one quarter of a line in height by one half a line in diameter. With the aid of a magnifier the entire surface is seen to be covered with minute granules; they are so numerous that in well preserved specimens the outlines of the tube orifices can not be traced. Tubes small, rather thin-walled, of unequal sizes, from ten to fourteen of those situated between the monticules, occupying the space of one line, without any minute interstitial tubuli. Tube mouths polygonal or floriform, their margins carrying a row of inwardly projecting, minute tubercles or granules.

From *A. hirsuta* this species is distinguished by its more profusely granulated tube walls, groups of larger sized calices, and in the less compact monticules. The growth of *A. multigranosa* is peculiar, being very irregular, in consequence of a greater development at some parts of the colony than at others; in *A. hirsuta* the thickness of the expansion is nearly equal in all parts. In *A. ortoni*, Nicholson, there

are no groups of larger sized tubes, the monticules are conical, and regularly arranged.

Formation and locality: all the specimens examined were found in the Cincinnati Group at Hamilton, Butler Co., Ohio. It is not a common fossil.

Collectors: H. E. Dickhaut, E. O. Ulrich.

Atactopora mundula, n. sp. (Plate XII., figs. 4, 4*a*.)

[Ety.—*Mundulus*, neat.]

Bryozoary parasitically attached to the fronds of *Chætetes* (*Monticulipora*) *mammulatus*; grows in thin expansions of less than one inch in diameter; thickness less than one half a line. Surface at regular intervals raised into rather prominent tubercles, placed a little more than one line apart (measuring from center to center), and arranged in diagonally intersecting lines: surface of monticules occupied by calices of the ordinary size. Tubes polygonal, with thick walls, the interstitial spaces occupied by numerous minute tubuli, that are best observed in worn specimens. Tube mouths small, of very irregular shape, but of nearly equal size, ten to twelve in the space of one line; pseudo-septa well developed, varying from two to five in each tube. No spines nor granules appear to have been developed; the superior ends of the septal ridges, however, sometimes are a little prominent, and thus simulate spines.

Although closely related to *A. ortoni*, Nicholson, this species has certain characters by which it can be easily distinguished from that form. In that species the walls of the tubes are rather thin and granulated, and there are no true intertubular cells, while in *A. mundula*, the walls are thick, not granulated, and are provided with numerous interstitial cells. The monticules are larger and not compact as they are in *A. ortoni*. Worn examples of *A. multigranosa* bear some resemblance to this species, but the thinner walls, non-tubular intercellular spaces, irregular growth and disposition of the maculæ in that species, will serve to distinguish them.

Formation and locality: near the tops of the hills about Cincinnati, O.

Collector: E. O. Ulrich.

Atactopora tenella, n. sp. (Plate XII., figs. 5, 5*a*.)

[Ety.—*Tenella*, delicate.]

Bryozoary, like that of the foregoing species, parasitic, forming exceedingly thin, irregularly outlined expansions, of an inch or more in

diameter; all the specimens examined are attached to fronds of *Chætetes* (*Monticulipora*) *mammulatus*; thickness of colony not exceeding one sixth or one fourth of a line. Distributed over the surface at distances apart of one or one and a half lines, are low and rather broad monticules, which carry groups of slightly larger sized tube calices than the average, and occasionally a few minute tubuli. Monticules variable in size and height, while their arrangement can scarcely be called regular, though an approach is made toward such a feature. Tubes thin-walled, sub-equal, somewhat oblique to the surface near the margin of the expansion, but becoming more direct as the middle of same is approached. Tube calices oval to sub-rhomboidal, about eight in the space of one line, their margins thin, and carrying at the angles of the tubes small spines, which, when worn, prove to have been hollow; these hollow spines probably are of the same nature as the intertubular cells in many bryozoa. Pseudo-septa quite prominent, varying in number from three to five in each tube.

A. tenella is closely allied to both *A. ortoni* and *A. mundula*. From the former it is distinguished by the compact character of the monticules, the presence of granulated tube walls, and absence of intertubular cells in that species. From *A. mundula* it is separated by the larger size of the tubes, less prominent tubercles, thinner tube walls, and smaller number of interstitial cells in *A. tenella*.

Formation and locality: found near tops of hills about Cincinnati, O. Collector: E. O. Ulrich.

ATACTOPORA SUBRAMOSA, n. sp. (Plate XII., figs. 6, 6*a*, 6*b*, 6*c*.)

[Ety.—*Subramosus*, somewhat branching.]

This is not a truly parasitic species, though attached by a broadly expanded base to foreign objects. In certain portions of the bryozoary there appears to have been an excessive growth, the consequence of which was the development of large nodes, or of short and thick branches. Diameter of branches about four lines. Surface without monticules. Tubes small, polygonal, quite irregular in size and arrangement, and with numerous minute intertubular cells; the latter are at irregular intervals collected into groups; of the interstitial tubuli the groups alone are distinguishable on the surface, those interspersed between the ordinary tubes being apparently closed, and can only be detected in thin sections. Tube calices of irregular shape, usually nearly closed by accretions to the margins; in the open calices the margins are thick and smooth; pseudo-septa not invariably developed.

few in number, probably never more than three, and generally only one or two in each tube. From eight to ten, or even twelve tubes occupy the space of one line.

Longitudinal sections show the tubes to be transversely divided by diaphragms, placed at corresponding levels in contiguous tubes. The diaphragms are about two thirds of a tube diameter apart. The tube walls in the lower portions of the tubes are very thin; they become thicker as the surface is approached. A peculiar feature is the periodic swelling of the walls at heights coincident with the tabulæ. In the minute tubuli the diaphragms are more closely set than in the larger tubes.

It would be quite impossible to confound this species with any other form, since it differs more or less in nearly all particulars from those previously described.

Formation and locality: the species occurs in the upper beds of the Cincinnati Group, at Jacksonburg, Butler Co., Ohio.

Collector: E. O. Ulrich.

Atactopora septosa, n. sp. (Plate XII., figs. 7, 7*a*, 7*b*, 7*c*.)

[Ety.—*Septosus*, having partitions or septa.]

A ramose species, growing from an expanded base, by which it is attached to foreign bodies. Branches bearing considerable resemblance to those of *Chætetes* (*Monticulipora*) *pulchellus* or *fletcheri*. Surface exhibiting low, broad and rounded tuberosities; which are placed at distances apart of about one line, and carry groups of larger tubes than those of the ordinary size. Tubes small polygonal, quite regularly arranged, without any minute interstitial cells; walls thin; about eight of the tubes, of average size, occupy the space of one line; about six of the tubes of larger size, occupy the same space. Pseudo-septa well developed, more easily detected in slightly worn specimens than in those perfectly preserved; from one to five in each tube.

In longitudinal sections the tubes are seen to be nearly vertical in the middle of the branch; here they have very thin walls, and are crossed by excessively thin and remote tabulæ; they then bend abruptly outward, and as the surface is approached the tabulæ are more closely set, and the walls become stouter; here also the pseudo-septa make their appearance, as is demonstrated by the darker lines which extend parallel with, and between, the true walls of the tube. The diaphragms are so thin that they can easily be overlooked.

In tangential sections the pseudo-septa are very conspicuous, and

usually number three or four in each tube. Transverse sections show the tubes in the center of the branch, to be polygonal, without minute intercellular tubuli, and with very thin walls.

From an external examination, when the pseudo-septa are not visible, it is not an easy matter to distinguish specimens of this species from certain varieties of *Chætetes* (*Monticulipora*) *pulchellus*; but when worn there is no difficulty, as the septa, when viewed through a hand lens, give a peculiar and characteristic appearance to the specimens. Of course tangential sections will immediately demonstrate their distinctness. The ramose growth of the species will distinguish it from the other species of *Atactopora*.

Formation and locality: specimens of this species are not uncommon on the hills back of Covington and Cincinnati, at an horizon of about three hundred feet above low water mark in the Ohio river.

Collectors: J. Ralston Skinner, E. O. Ulrich.

Genus Stellipora (Hall.)

Stellipora limitaris, n. sp. (Plate XII., figs. 8, 8*a*, 8*b*, 8*c*.)

[Ety.—*Limitaris*, on the border.]

Grows in cylindrical or sub-cylindrical, sometimes hollow branches, the diameter of which varies from three to five lines; or in small lobate or sub-palmate masses. Branches in the ramose examples dividing dichotomously at varying distances, irregularly thickened and nodulated. Surface with the tube-mouths on all sides, the tubes cylindrical and radiating in all directions from an imaginary central axis. Scattered, generally over the entire surface, are numerous stellate spaces, each of which has a diameter of a line or a little more, sometimes considerably depressed, but usually on a level with the surrounding surface; the number of the rays radiating from the body of the star varies from five to eight; these frequently bifurcate once or twice, and unite with those emanating from the adjacent stars, thus producing a sort of net-work. The stars are usually regular in outline, sometimes elongated, and arranged in rather irregular transverse or oblique rows, three stars generally occupying a space of three and a half lines; it is however not very rare to find specimens with a portion of the surface destitute of the stellate spaces. The central area and the rays of the stars are composed of aggregations of very minute sub-angular tubuli, but appear to be solid, unless examined with a sufficiently high magnifying power. The surface between the stellate maculæ is covered with small circular calices, the margins of which, in protected parts,

are slightly raised; from six to eight tube orifices occupy the space of one line. Intertubular space about one third as thick as the width of the tube mouths, and minutely tubular.

Longitudinal sections of the branches present the tubes as proceeding in a gentle curve from the middle or axis of the branch to the surface, and as they approach the surface and have arrived to within one line of the same, they bud off one or two more slender tubes; the tubes before they have been thus multiplied are traversed by complete and close tabulæ, a little more than one tube diameter apart. Near the surface the tubes are of two kinds, smaller and larger ones; the former are at intervals collected into groups, which represent the stellate maculæ on the surface; between these the remaining tubes are placed alternately, one larger and one or two smaller; the large tubes representing the true cells, while the smaller ones represent the minute tubuli in the intercellular spaces. The diaphragms in both kinds of tubes are close set, about two thirds of a tube diameter distant from each other.

In transverse sections the tubes near the margin are seen to be cut longitudinally, while in the center they are divided transversely, and here they are thin-walled and generally with an hexagonal outline.

In sections taken parallel with and close to the surface, the stellate spaces are seen to be occupied by a net-work of sub-angular cells. The tubules are circular, and fill up the space not occupied by the maculæ; they are separated by a similar net-work of minute cells as those composing the maculæ.

This species in its external characters approximates closely to *Fistulipora*, McCoy, since the stellate and intertubular spaces in their structure are essentially the same as the cellulose tissue, of which the intertubular spaces and maculæ, in most of the species of that genus, are composed. *Fistulipora (Callopora) incrassata*, Nicholson, has star-like spaces, occupied by very minute tubuli, but these spaces have no radiating ridges surrounding them. In *S. limitaris* there are also none of these ridges, and in these two species the resemblance is very manifest. On the other hand, in sections of *S. limitaris*, taken parallel with and close to the surface, we find a striking similarity to sections of the same kind of *Chætetes decipiens*, Rominger, and *C. frondosus*, D'Orbigny, while in longitudinal sections much affinity is presented to several ramose species of *Chætetes*. The species of *Stellipora* and their numerous varieties, in fact, are connecting links between *Chætetes* and *Fistulipora*. *Stellipora antheloidea*, Hall, is distinguished from this species, exteriorly, by its sub-frondescent growth,

by having the spaces between the rays of the stellate maculæ raised, and the tubes smaller. Interiorly we find that the tubes in the middle of the branch or frond are crossed by remote tabulæ, and as they approach the surface the curve is more abrupt than is the case in *S. limitaris.*

Formation and locality: the type specimens were found by the author, in the upper part of the Cincinnati Group, at Clarksville, O.

Chætetes granuliferus, n. sp. (Plate XII., figs. 9, 9*a*, 9*b*).

[Ety.—*Granula*, a grain; *fero*, to bear.]

Bryozoary composed of sub-cylindrical stems, which divide dichotomously at varying distances, are sometimes irregularly thickened and nodulated, and have a diameter of from two to five lines. Surface generally smooth, but sometimes exhibiting obscure tubercles with a distance of one and a half lines between them; at other times again the maculæ, instead of being raised into tubercles, are depressed below the general surface, and composed of groups of minute tubuli. Tube apertures, varying from circular or oval to sub-polygonal, of unequal size, usually with groups of slightly larger-sized tubes, which occupy the monticules when any are developed; intercellular spaces extremely thick, when well preserved are strongly granulated, sometimes to such an extent as to obscure the calices; when slightly worn the granules or spines are seen to be simply surface extensions of curiously modified minute tubuli; this fact is demonstrated even more clearly in sections taken from near the surface and parallel with the same; the number of these interstitial tubuli, and consequently of the spinulæ varies considerably in different specimens.

In longitudinal sections the tubes are seen to be quite vertical in the center of the branch, and to bend outwards to the surface in a regular curve, forming an angle of about fifty degrees with the plane of the surface. The diaphragms are very numerous in the tubes near the surface, becoming gradually less so toward the middle or vertical portion of the tubes; here they are about two tube diameters distant from each other. In transverse sections the tubes are rather thin-walled, polygonal, and divided by faint, cruciform lines, similar to those noticed in sections of this kind, of other species of *Chætetes.*

Well preserved examples of this species can not be confounded with any other species found in the Cincinnati Group. Worn specimens, however, are not so easily distinguished from *C. briareus*, Nicholson. By a close examination we find the latter to have much less numerous

(in fact to be almost without) intertubular cells, smooth, calice margins, and thinner intertubular spaces. From *C. fletcheri*, Edwards and Haime, and other ramose species, it is distinguished by the strongly granulated and thick tube walls.

Formation and locality: not uncommon at Frankfort, Bergen, and other localities in Kentucky, where the lower strata of the Cincinnati Group are exposed. Collectors: Rev. H. Herzer, E. O. Ulrich.

CHÆTETES IRREGULARIS, n. sp. (Plate XII., figs. 10, 10*a*, 10*b*.)

This form grows in small, free, and exceedingly irregular masses, having a diameter varying from less than three lines to fifteen lines. Surface rarely nearly smooth, but is generally irregularly and strongly nodulated. Apertures of tubes polygonal, nearly equal in size, from eight to ten occupying the space of one line; walls of tubes comparitively thin. Interstitial tubuli are entirely absent.

Longitudinal sections of this species have a peculiar and unique appearance. The tubes are seen to radiate from various centers, which correspond in number to that of the prominent nodules observed on the surface. Transparent sections were taken from many specimens, but no tabulæ were observed crossing any of the tubes. When the tubes are cut transversely they are seen to be thin-walled and polygonal, with sometimes a small or young tube interpolated. The calcite filling the tubes is of darker and lighter shades, giving sections a peculiar appearance, and when the ends of the tubes are observed, it is divided by quite regular but faint cruciform lines, as in *C. quadratus* and several other forms.

This species is allied to *C. lycopodites*, but is easily distinguished by its peculiar growth, and in having no diaphragms crossing the tubes. It is also related to *C. subglobosus*, but that species differs in having a more regular form, larger calices, and flexuous or wrinkled tube-walls. *C. irregularis* marks a horizon of about five hundred and fifty feet above low water mark in the Ohio river at Cincinnati, and is nearly always found where that elevation is exposed.

Formation and locality: Cincinnati Group. The best localities known to me for obtaining this fossil, are at Hamilton and Morrow, Ohio, at which places I obtained a large number of specimens.

CHÆTETES SUBGLOBOSUS, n. sp. (Plate XII., figs. 11, 11*a*, 11*b*.)

[Ety.—*Subglobosus*, somewhat globose.]

Bryozoary free; form globular to pear-shape; diameter from three to

six or eight lines; surface without tuberosities. Apertures of cells, on the upper portion of the colony, usually polygonal, sometimes subcircular, and equal in size, about five occupying the space of one line; at the base the calices are generally larger and oval; walls of tubes moderately thick, with the exterior, as is seen in fractured examples, strongly wrinkled or annulated. Longitudinal sections show the tubes radiating from the obtusely pointed base in curved lines to the surface. The walls are flexuous, and of variable thickness; no tabulæ were observed in any of the tubes. Sections of this kind clearly show that the tubes were multiplied by gemmation. Transverse sections show the calcite filling the tubes divided into four parts by very distinct cruciform lines. This feature, occurring in a number of forms, is a very peculiar one, and is as yet not understood.

This species appears to have been gregarious, since it is almost exclusively found in what are termed "pockets."

I know of no form from the Cincinnati rocks with which this species could be confounded. It is probably most nearly related to *C. petropolitanus*, Pander, but the distinct groups of larger tubes, the hemispherical form, and the well developed tabulæ in that species, will amply serve to distinguish them.

Formation and locality: rather abundant in the lower part of Cincinnati Group, at Covington, Ky., and at Batavia, Ohio.

CHÆTETES ELEGANS, n. sp. (Plate XII., figs. 12, 12*a*.)

[Ety.—*Elegans*, elegant.]

Bryozoary free, growing in exceedingly thin, circular expansions, not more than one fourth of a line in thickness, and from one half an inch to one inch and a half in diameter; the expansions, on account of their great tenuity, are usually much flattened by pressure, but originally, as is seen in well preserved specimens, they were rather convex. Surface exhibiting numerous, rather low, rounded tuberosities, the bases of which are in contact or nearly so; the monticules are arranged in diagonally intersecting rows, and have a diameter averaging about two and one half lines; the cells which cover their sides and summits gradually increase in size, until they have attained a diameter at the summit that is equal to nearly twice that of the cells which are situated in the depression between the tuberosities. Cells with moderately thick walls, arranged in diagonal lines, the regularity of which is slightly disturbed by the increased size of those occupying the monticules; apertures diamond-shaped or approximately hexago-

nal; about ten of the ordinary or smaller sized cells occupy the space of one line. None of the specimens examined exhibit minute interstitial tubuli. Under surface not observed.

This is a very beautiful species, which can readily be distinguished from the other discoidal species of the genus, by its very broad, low monticules, and the regular arrangement of the cells, as well as by the large size of those occupying the monticules.

Formation and locality: occurs at an elevation of about three hundred and fifty feet above low water mark in the Ohio river, in the Cincinnati Group, at Cincinnati, O.

Collectors: J. G. Fine, H. Dickhaut, E. O. Ulrich.

DESCRIPTION OF A TRILOBITE FROM THE NIAGARA GROUP OF INDIANA.

By E. O. Ulrich.

Calymene nasuta, n. sp.

[Ety.—*Nasutus*, snouted.]

General outline sub-ovate, the breadth and length being respectively as five to seven; convexity just anterior to the pygidium about three fourths the width at that point; convexity at anterior portion of thorax and of cephalic shield as one to three or four.

Cephalic shield, without the remarkable proboscis or frontal extention, sub-semielliptical, approaching sub-lunate; the anterior border being more or less regularly rounded, and the posterior somewhat sinous; posterior lateral extremities abruptly rounded or sub-angular; glabella prominent and strongly defined from the cheeks and front margin by deeply impressed furrows; the two posterior pairs of lobes are distinctly defined by deep lateral furrows, which, especially in the posterior pair, pass almost completely around the lobes; the latter are about twice as large as the former, while the anterior pair are very small, all being nearly round; central portion of glabella much wider at base of frontal prolongation than at the neck furrow, which is well defined; neck segment prominent, slightly larger than the first thoracic segment, and considerably arched forward. Front margin recurved, remarkably extended upward and forward, in the form of a compressed and blunt cone, or the superior margin may be more rounded; the length of this proboscis varies, according to the size of the specimen,

from three eighths to five eighths of an inch. Eyes small, rather prominent, and situated opposite the middle lateral lobes of the glabella. Movable cheeks, with rounded and very thick lateral margins, defined by a distinct marginal furrow, which is continuous with that separating the frontal extension from the anterior end of the glabella; here the furrow is very narrow and deep. Fixed cheeks provided with a

Fig. 1.

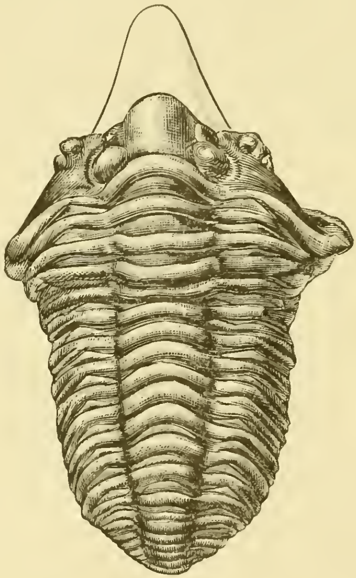

Fig. 2.

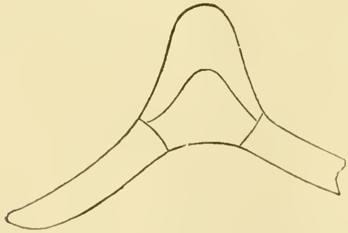

Fig. 3.

deep, broad, furrow along the posterior margin. Facial sutures directed forward anteriorly to their intersection of the margin in nearly parallel lines; posterior to the eyes they bend toward the glabella, then abruptly outwards, and run nearly parallel with the posterior margin of the shield to a point about one half the distance from the lateral

margin of the head to the glabella; from this point they pass in a slightly curved direction to a point a little within the posterior lateral angle of the cheeks. Frontal suture passing from the intersection of the facial suture and the anterior margin on one side, upward on the front face of the proboscis to a point about midway the length of the same, where it bends at a right angle and proceeds to the intersection ot the facial suture on the other side. Labrum not observed.

Thorax with thirteen segments, narrowing backward and about one sixth longer than wide ; mesial lobe not as wide as the lateral, very prominent and depressed on top, with the segments strongly defined and arched forward in the middle and at their ends. Lateral lobes flattened on the inner third, then strongly rounded off until the direction to the lateral margin is nearly at right angles to that in the inner third; pleuræ slightly curved backward to their outer ends, which are rounded, compressed, expanded, and provided at their posterior edge with a thickened marginal ridge, which becomes gradually stronger to their junction with the segments of the mesial lobe; each provided with a well-defined longitudinal furrow ; on the inner third, and just anterior to the furrow, there is a rather prominent ridge which is placed behind, and usually in contact with, the next succeeding segment.

Pygidium a little wider than long, and as long as the middle of the cephalic shield, exclusive of the frontal prolongation; a direct posterior view shows the outline to be semi-circular or broadly semi-ovate, the base appearing straight; viewed from above it is more or less subtrigonal; mesial lobe well defined, depressed convex, and extending at least three fourths the distance to the posterior margin, showing four segments, and very obscurely a fifth; behind these there is a sub-triangular space that is not segmented. Lateral lobes sloping off very rapidly, each with four segments, all of which have a slightly defined longitudinal furrow. Lateral and posterior borders with a thick margin, which on the exterior is only conspicuous beneath the last segment of the mesial lobe.

Dimensions of a medium-sized specimen: entire length, 2.8 inches; length of cephalic shield, inclusive of frontal prolongation, 1.0 inch; width of cephalic shield, 1.9 inches; length of glabella and neck furrow, from base of snout, .69 inch; width of glabella across posterior lobes, .69 inch; length of snout from base in front to apex, .75 inch; greatest width of thorax (just posterior to the cephalic shield), 1.56 inches; length of same, 1.8 inches; greatest width of pygidium, .8 inch; length of same .65 inch.

The most striking feature of this trilobite is the very remarkable de-

velopment of the frontal margin of the shield. In all other respects (if we except its larger size) much resemblance is presented to *C. niagaraensis*, Hall. The differences between the two are, however, sufficiently marked, and there can be but little danger of confounding one with the other.

Formation and locality: a rare species occurring in the lower beds of the Niagara Group, at Osgood, Ripley county, Indiana.

Collectors: J. Ralston Skinner, C. Mullalley, E. O. Ulrich.

DESCRIPTIONS OF NEW SPECIES OF CRINOIDS. FROM THE KASKASKIA GROUP OF THE SUBCARBONIFEROUS.

By A. G. Wetherby,

Prof. of Geology and Zoology, University of Cincinnati.

The crinoids described in this paper were collected by me, in subcarboniferous rocks of the Kaskaskia Group, in Pulaski county. Kentucky. The genus Pterotocrinus was fully discussed in a previous article, and its relationships made out so far as the specimens permit. The unequaled preservation of these fossils has made their specific identification an easy task.

Pterotocrinus acutus, n. sp.

[Plate XI., fig. 2*a* upper, 2*b* basal, 2*c* side view, natural size.]

Basals—Two, pentagonal, centrally excavated dorsally and laterally for the reception of the slender column. Their line of junction, produced. passes through the center of the latter, of the azygos plate, between the inner edges of the first radials on the azygos side, and through the center of the first radial upon the opposite side. These plates are thickened and slightly carinated at the outer edges of the columnar excavation.

Radials—First series five, the two on the azygos side heptagonal, wider than high, laterally excavated inwardly for the reception of the convex sides of the azygos plate, above the apex of which they unite. completely inclosing it.

The opposite, or anterior first radial is heptagonal, wider than high. with a slight central angle on the basal side. It is excavated on the opposite face for the reception of the small second radials, which meet in a line over its center.

The other two first radials are hexagonal, wider than high, and nearly like the last, except that they join the basal by a single side.

The radials of the second series are ten in number, irregularly quadrangular, lying upon the central upper faces of the first radials, about one half of which they cover. They join, laterally, the third radials, which rest upon them and the extremities of the first radials.

The radials of the third series are twenty in number, irregularly quadrangular, nearly three times as wide as high. Four of these occupy the space of the upper face of each first radial, two of which rest upon the second radials, and the other two upon these and the extremities of the first radials.

Azygos piece—This is quadrangular, the inner faces being straight, and meeting the basals in a sharp angle at their line of junction. The lateral faces are convex, and embraced by the concave sides of the first radials.

Brachials—Of these there are sixty, in series of threes, resting upon the third radials, which they resemble, except that the middle one of each series is slightly higher than the others, and bears upon the center of its outer surface a stout, short spine, which is in a line with the center of the brachial and third radial below, and that of the brachial and junction of the double series of arm plates above.

Arms—Twenty in number, composed of a double row of alternately interlocking pentagonal plates, about forty on each side. These plates shorten and widen gradually towards the extremities of the arms, which are long enough to fold over into the central area of the summit, at the base of the interbrachial rays. They are centrally excavated on the ventral side, and bear two rows of stout pinnulæ. These are few jointed, and excavated like the arms.

Interbrachial Rays—Five, awl-shaped, thickened and rounded at the base, and gradually tapering to a somewhat blunted point. They are slightly bent downward at the middle, giving the species a peculiarly graceful appearance. Their position, and the manner of their articulation to the vault, as well as the description of the latter, may be learned from my review of the genus in this Journal, April, 1879.

Column—Small, round, composed of alternately thicker and thinner plates. Columnar canal round.

Remarks.

As will be seen from the figures accompanying the description, this species has the body somewhat depressed, it being but little higher than wide. This form is due mainly to the slender character of the second and third radials, and the brachials. All the specimens yet found have the top of the vault capped by a Gasteropod.

The awl-shaped rays, and the spines borne by the second row of brachials, at once distinguish this species from all others yet described.

Locality and position: Kaskaskia (Chester) Group, sub-carboniferous, Pulaski county, Kentucky.

PTEROTOCRINUS BIFURCATUS, n. sp.

Plate XI., fig. 1*a* upper, 1*b* basal, 1*c* side view, natural size.

Basals—Two pentagonal, deeply excavated centrally for the columnar pit, and which bears a prominent carina at its edges. They are much thickened in this region, and slope away rapidly to the first radials.

Radials—First series five, the two on the azygos side heptagonal, wider than high, laterally excavated for the reception of the azygos plate, which they completely embrace, and much resembling, in their general features, the same plates in the *P. acutus* herewith described.

The opposite first radial is heptagonal, somewhat widei than high, and has a slight angle on the inner side, which points to the line of junction of the basals. The other two first radials are hexagonal, wider than high, and resemble the anterior one in outline, save that they abut upon the basals by a single side instead of two.

The radials of the second series are irregularly quadrangular, ten in number, small, closely united or nearly anchylosed to the first, and cover a little more than one half the upper side. They are enclosed, laterally, by the outside pairs of third radials.

These latter are twenty in number, irregularly quadrangular, and nearly as high as wide. Their position in reference to the adjacent plates is the same as that of the other crinoids of this genus. The ratio of height to width is less that in any of the other species described in this paper.

Azygos piece—This is quadrangular, the inner faces being straight, and meeting the basals in a sharp angle at their line of junction, as in *P. acutus* herewith described. The other sides are convex and embraced by the first radials.

Brachials—Of these there are sixty, in series of threes, resting upon the third radials, and differing from them very slightly in form. There is evidence in one or two cases that these plates were tuberculated, though very slightly.

Arms—Twenty, composed of a double row of alternately interlocking plates, about forty to each side, each of which bears a stout pinnule. The arms are thick at the base, and taper very gradually, as the plates shorten towards their extremities. As in the other species,

the arms were long enough to reach to the center of the depression at the base of the rays, which space is filled, as may be seen in the figure of the type, by a Gasteropod, which rests upon the top of the vault, hiding its cap-piece, of which the form is unknown.

Interbrachial Rays—Five, very wide, much thickened, somewhat convex above, more so below, and widely bifurcate at the extremities. As will be seen in the figure, these divisions from opposite rays reach and even over-lap each other. It is clearly shown in the type, and in fragmentary specimens, that the rays are articulated to the vault alone, and not to the body plates. They are, as was first suggested by Meek and Worthen (Geo. Sur. Ill. vol. ii., p. 290), true vault pieces, or at least they have no connection with the other parts that can be determined from the specimens studied, which are sufficient in numbers, and in excellent preservation in most cases. In some of the species the weight of these rays exceeds that of all the other parts of the crinoid combined; in others they are very thin, light, and either narrow and long, or wide (high) and comparatively short.

Locality and position: Kaskaskia (Chester) Group, sub-carboniferous, Pulaski county, Kentucky.

All the species described in this paper were collected by me in the sandy shales, forming the upper part of this group, at the locality above cited, and the types are a part of my cabinet of sub carboniferous fossils.

Pterotocrinus spatulatus, nov. sp.

Plate XI., fig. 3*a* upper, 3*b* basal, 3*c* side view.

Basals—Two, small, pentagonal, slightly elevated below, and excavated, centrally, on their line of junction, for the reception of the slender column. The anal piece rests upon their angular excavation on the azygos side, and the first radial upon the other.

First radials—Five, having the form usual to the genus, wider than high, all excavated centrally, for the reception of the small second radials, which cover about one half their upper surface, leaving the outer extremities exposed.

The great width of these plates, in comparison with their height, causes the flattened form of the cup characteristic of this species.

Second radials—Ten, irregularly quadrangular, wider than high, resting upon the upper central surface of the first radials, and covering about one half this side of each.

Third radials—Twenty, in groups of fours over the first radials, irregularly quadrangular, wider than high, the central two of each

group resting upon the second radials, the others upon the outer extremities of the first radials.

Brachials—Sixty, in series of threes over the third radials, which they resemble in size and form, except that the upper one is slightly wedge-shaped.

Arms—Twenty, in groups of fours between the interbrachial rays, composed, as in the other species, of a double series of interlocking plates, each of which bears a stout pinnule. The arms are large enough to fold over to the central space between the bases of the interbrachial rays, and gradually taper to their extremities.

Interbrachial rays—Five, somewhat thickened above, much thinner on the inferior side, also thickened at the proximal, and very much attenuated at the distal extremities.

They are very much excavated, centrally, on the ventral or upper side, giving this surface a concave outline, while they are slightly convex below. The extremities are rounded, and the outer half of the ray has the closest resemblance to the blade of a spatula. The rays are articulated to the five angles of the vault, as shown in my review of this genus, and are a part of it

The upper part of the vault, in all the specimens, is covered by a Gasteropod, the shape of the shell accommodating itself to the space at the base of the rays.

Column—Very slender, round, and composed of thin plates, there being fourteen in three eighths of an inch.

The specimens from which this description has been drawn are all somewhat crushed, and the exact proportions of the body are difficult to determine. But it is much wider than high, and this depressed form arises from the shape of the plates as above described.

From all species of the genus hitherto defined, this one differs in the form of the interbrachial rays.

Locality and position: In rocks of the Kaskaskia (Chester) Group, sub-carboniferous, Pulaski county, Ky.

FORBESIOCRINUS PARVUS, n. sp.

Plate XI., fig. 4*a* azygos, 4*b* opposite side.

Basals—Three, triangular, thin, and having their articulating sutures covered by the first section of the column. Though the generic formula of this genus, as established by its illustrious authors, has been modified by calling these pieces basals, I am much in doubt as to the propriety of such a conclusion. It is likely that a careful study will show the column to be thus divided for some distance below the body.

Sub-radials—Five, four pentagonal, the one on the azygos side hexagonal, and somewhat larger than the others. All are about as wide as high, with the upper extremity pointed, and completely embraced by the first radials, except the one on the azygos side, which is truncated, and supports the first azygos plate.

Radials—In one specimen, four to each ray, or twenty in all, while in other specimens two of the rays have four each, the others having, three. The first plates of the radial series are distinctly pentagonal, somewhat higher than wide, and alternate with the sub-radials, a line passing through their center being continuous with the sutures uniting the latter. The second and third plates of this series vary somewhat in form, owing to their articulation to the inter-radial and azygos plates, but are either hexagonal or irregularly quadrangular, those of the two rays bounding the azygos side varying somewhat from the others. The fourth radials (or third in rays having but three radials) are axillary, distinctly pentagonal in each ray of every specimen, wider than high, and are the most regular in form and size of any plates in the radial series.

Upon these radials the first bifurcation takes place, the first brachial plates resting upon their outer, sloping, upper sides.

Of the brachial plates, before the second bifurcation, there are two in each ray of every specimen, the first or lower of which is quadrangular, higher than wide, and all are remarkably uniform in shape and size. The second brachial is, in all cases, pentagonal, and upon its sloping upper sides, rest the first plates of the series resulting from the second bifurcation which takes place on them. Above this division the arm plates are continued in series of threes, two of which are irregularly quadrangular, and much longer than wide, while the third is pentagonal, and gives rise to the third and last bifurcation.

Inter-radials—Five to seven in each space, hexagonal and pentagonal in form, the lower one hexagonal and resting with its pointed lower extremity in a line with the suture of the contiguous first radials.

Azygos pieces—Five to seven, the lower one resting upon the truncated upper extremity of the sub-radial on that side.

No inter-axillary pieces are to be found in any of the specimens which are in a very fine state of preservation, showing the features set forth in the most satisfactory manner.

As will be seen from the description, the number of arms after the third division is forty. The final extremities of these are so folded over the ventral side of the specimens as to completely hide the vault, if any, as likewise the pinnulæ. Several of the rays show evidences

of the small plates often found in this genus attached to the outer center of the brachials. They are, however, not uniformly present in any arm of any specimen.

The mere fragment of the upper part of the column attached to a single specimen is composed of very thin plates, and gradually tapers downward from the body of the crinoid.

Locality and position: Kaskaskia (Chester) Group, sub-carboniferous, Pulaski county, Kentucky.

NORTH AMERICAN MESOZOIC AND CÆNOZOIC GEOLOGY AND PALÆONTOLOGY.

By S. A. Miller, Esq.

The sciences of Geology and Palæontology had not advanced many steps, in Europe, before their growth had commenced in America. Their development, therefore, has been nearly contemporaneous in the two countries, though more rapid in the early part of the century in the Old World than in the New. Europe has had William Smith, J. S. Miller, Sowerby, Murchison, Lyell, Brongniart, D'Orbigny, Goldfuss, Sternberg, Barrande, and many other distinguished authors; while America has had McClure, Morton, Vanuxem, Hitchcock, Conrad, Leidy, Hall, Lesquereux, Logan, Billings, Dawson, and others, original discoverers, who possessed the philosophical learning necessary for the correct application of the discoveries to the advancement and growth of the sciences. The facts, however, upon which these sciences are based, and which constitute the superstructure, as now understood, have been ascertained, so recently, that one would hardly undertake to enumerate a score of the principal fathers of them, in either country, without mentioning the names of some who are still living.

The first society organized for the advancement of science in North America, of which we have any account, is the American Philosophical Society, instituted in 1769, in Philadelphia. The earliest geological papers that seem to be worth mentioning, appeared in the Transactions of this Society, and though its publications have not been rapid, they continue to appear, and to hold a high rank, whether devoted to Geology, Palæontology, or other departments of science. The society is indebted for its organization to Benjamin Franklin. The first volume of the Transactions appeared, in quarto, in 1771.

Belknap wrote, upon the White Mountains, in 1784; Hutchins, on the Rock and Cascade of the Youghiogheny, in 1786; William Dunbar, on large mammalian bones found in Louisiana, a set of human teeth found while digging a well at the depth of 30 to 35 feet; and on the Mississippi river and its delta, in 1804, which was continued in 1809. B. H. Latrobe described the freestone quarries on the Potomac and Rappahannock, in 1809; and William McClure, in the same year, published his Observations on the Geology of the United States, explanatory of a geological map. He divided the formations into four classes, viz: 1st, Primitive rocks; 2d, Transition rocks; 3d, Flœtz or Secondary rocks; and 4th, Alluvial rocks. These classes he separated on their mineralogical characters, and he treated of their dip and extent, as far as his observations permitted. And Thomas Jefferson, who had been President of the United States, described the fossil bones of the Megalonyx, in 1818.

The American Academy of Arts and Sciences was established in Boston, and commenced the publication of its Memoirs in 1780. The Academy of Natural Sciences, of Philadelphia, originated in 1812, but commenced its publications in 1817. It soon collected an extensive library of works upon Natural History, largely owing to the fine donation by the generous and distinguished geologist, William McClure, and at once entered the field as an active society, alive to the importance of the publication of facts, as distinguished from theoretical considerations. Its publications, from the commencement, have occupied the first rank in science, and are now, absolutely, indispensable to every American naturalist, and should occupy a shelf in every public library.

An idea of the absence of geological information, in this country, in 1803, may be formed when it is remembered that geology was not separated as a science from mineralogy, and that so little was known of mineralogy that it could hardly have ranked as a science; for later in life, Prof. Silliman, speaking of this period, says, "it was a matter of extreme difficulty to obtain, *among ourselves* even, *the names* of the most common stones and minerals; and one might inquire earnestly, and long, before he could find any one to identify even *quartz*, *feldspar*, or *hornblende*, among the simple minerals; or *granite*, *porphyry*, or *trap*, among the rocks. *We speak from experience*, and well remember with what impatient, but almost despairing curiosity, we eyed the bleak, naked ridges, which impended over the valleys and plains that were the scenes of our youthful excursions. In vain did we doubt that the glittering spangles of mica, and the still more alluring bril-

liancy of pyrites, gave assurance of the existence of the precious metals in those substances; or that the cutting of glass by the garnet, and by quartz, proved that these minerals were the diamond; but if they were not precious metals, and if they were not diamonds, we in vain inquired of our companions, and even our teachers, what they were."

An idea of the low state of Palæontology, in 1809, may be formed from a letter written by Parker Cleveland, Professor of Mathematics and Natural Philosophy, in Bowdoin College, and published in the Memoirs of the American Academy of Arts and Sciences, vol. iii., part 1. He had carefully watched the digging of two wells through sand and into blue clay; one of them was at a distance of about 20 miles from the sea, and three or four miles from the tide, in Cathance river, and had an elevation estimated at 70 or 80 feet above the tide. This well was dug 20 feet deep. The first 10 feet was through sand and gravel. At the depth of 10 feet a stratum of blue clay was found, which had the appearance and smell of that dug on flats, or near salt marshes. In this clay he found shells; one a clam, "two varieties of muscle," and one large conical form, whose generic name he knew not, but the same genus he said "is found on our sea shores." The other well was near Brunswick, 80 feet above tide water, in the Androscoggin, and half a mile from the river. At the depth of 12 feet, a four feet stratum of clay was found having the same smell, and containing shells plentifully interpersed, similar to those found in the well near Cathance river. He thought that important advantages would result from possessing a geographical map, indicating the different species of fossil shells, and the places in which they were found, especially where the country or coast might be thickly inhabited; because, he says, "with such a map before us, we should be better enabled to compare individual facts, and hence to draw several conclusions."

In 1818, Prof. Benjamin Silliman commenced the publication of the American Journal of Science and Arts, which, through his remarkable talent, and unbounded energy, at once took rank with the scientific journals of Europe. It has now reached the 119th volume, and the aid it has rendered the sciences of Geology and Palæontology is unmeasured.

In 1818, William McClure prepared an "Essay on the Formation of Rocks, or an inquiry into the probable origin of their present form and structure," which was published in the Journal of the Academy of Natural Sciences, of Philadelphia, vol. i., part 2. He says:

"Concerning the nature and properties of the great mass, which

constitutes the interior of the earth, we are entirely ignorant; few of our mines penetrate deeper than one fifty-thousandth part of the earth's diameter, under the surface, and none of them go beyond one twenty-five thousandth part of that diameter: it would appear, therefore, that any mere supposition concerning the actual and present state or the nature of those substances, which form the interior of the earth, is unsupported, as yet, by any reasonable analogy: and that all conjectures, concerning former changes, partial or total, in the nature and structure of those substances, are removed still farther from anything analogous, in our present state of knowledge."

"The earth being flattened, at the poles, does not necessarily imply its former fluidity. We may be permitted to doubt the analogy between our experiments on bodies moving, in our atmosphere, and the earth's motion in space; our total ignorance of the nature of the fluid, which occupies what is usually called space, tends to render the analogy inconclusive."

"May not the mode of casting patent shot be considered as an experiment, on the form which liquid bodies would take by a rotary motion? A drop of melted lead let fall from the height of 200 feet is completely globular, and not flattened at the poles; the lead might be thrown with force from the top of the tower, which would imitate the centrifugal force, as gravitation does the centripetal force, and make the experiment more analogous."

"The supposition that the earth was in a fluid state, when it took its present form, leads to the supposition that it was always so; and that fluidity was the original state of the earth, kept so by all the general laws and order of nature, all of which general order and laws of nature must be totally changed before the earth would take a solid form."

"On the supposition that the earth, previous to its fluid state, had existed always in a solid state, and that some creation or accident produced the fire or water necessary to its liquefaction, we have, in that case, first to suppose that the order and nature of the general laws, which had kept it always in a solid state, were totally changed to produce a fluid state; and that another change, in the general laws, which produced and kept it in a fluid state, must have taken place previous to its having become again solid."

"It may be doubted whether the uniformity, order and regularity of the general laws of nature, which have at any time come within the limits of our observation, can warrant a supposition founded on such complete changes in the mode of action."

"As we do not comprehend either the creation or annihilation of matter, by the origin of rocks, we mean the last change which produced their present form, and the agents that nature employed to give them that form, or effectuate that change."

He divided the rocks into three classes (not, however, without expressing grave doubts as to the correctness of his conclusions), as follows:

1st Class—of Neptunian origin. 1st Order: Sand beds, Gravel beds, Sea salt, Sandstone, Pudding-stone, Brown coal, Bog Iron ore, Calcareous tufa, Calcareous depositions, and Silex from hot springs.

2d Order, resembling in structure, position or component parts, the 1st order, the evidence of their origin resting on direct and positive analogy: Coal, Gypsum, Chalk, Compact limestone, Sandstone, Pudding-stone, Rock-Salt, Old Red Sandstone, Graywacke and Graywacke slate, Transition sandstone, Transition limestone, Transition gypsum, Transition clayslate, Anthracite and Siliceous schist.

2d Class—Volcanic origin. 1st Order, thrown out of active volcanoes, and resting on the evidence of our senses: Compact lava, Porous lava, Porphyritic lava, Scoria. Mud lava, Obsidian or Volcanic glass, Pumice-stone and cinders.

2d Order, resembling the 1st order in structure, position, and component parts, having the remains of craters, with currents of lava diverging from them; though the fire which may have formed them is now extinct, the evidence of their origin resting on direct and positive analogy: Basalt, Trap formation called by Werner the newest Flœts Trap formation, Pitchstone, Pearlstone, Porphyry attending the trap as above, and Clinkstone.

3d Order, where the rocks resemble the second in texture and component parts, but the proof of their origin resting on a more distant analogy: Basalt, Trap, Pitchstone, Porphyry, and Clinkstone.

3d Class—the origin doubtful, resembling a little, the 2d order of the 1st and 2d classes, but the analogy neither direct nor positive, amounting only to probable conjecture. 1st Order: such rocks as probable conjecture would incline to place in the Neptunian origin: Gneiss, Mica slate, Clay slate, Primitive slate and limestone.

2d Order, such rocks as probable conjecture would incline to place in the volcanic origin: Hornblende, Porphyry, Greenstone, Sienite and Granite.

The greatest good that this author accomplished may have resulted from constantly teaching that it is through observation, and not through the imagination, that a knowledge of Geology can be acquired. He said:

"The short period of time that mankind seem to have been capable of correct observation, and the minute segment of the immense circle of nature's operations, that has revolved during the comparatively short period, renders all speculations on the origin of the crust of the earth mere conjectures, founded on distant and obscure analogy. Were it possible to separate this metaphysical part, from the collection and classification of facts, the truth and accuracy of observation would be much augmented, and the progress of knowledge much more certain and uniform; but the pleasure of indulging the imagination is so superior to that derived from the labor and drudgery of observation—the self love of mankind is so flattered by the intoxicating idea of acting a part in the creation—that we can scarcely expect to find any great collection of facts, untinged by the false coloring of systems."

Very few facts, which now constitute the sciences of Geology and Palæontology were, at this time, known, and even later, theories and unwarranted assumptions constituted the greater part of what was taught as Geology, notwithstanding the exhortations of McClure, urging empirical study as against the injurious speculations and pretensions founded upon the imagination, or in the zeal to suppress investigation, because it seemed inimical to the teachings of the clergy. As a sample of what was taught, we may quote from Prof. Amos Eaton's "Index to the Geology of the Northern States," published in 1820.

He says, page 223 :

"I think I may say, with confidence, that the remains of two genera of animals, *Anomia* and *Pecten*, form, at the least, two thirds of all the secondary limerocks in North America. It may be deemed arrogant to include *all* the territory of this vast continent. But it has been my good fortune to see specimens of this rock from Canada to Mexico, and from Hudson's river to the Mississippi, taken from numerous localities. Perhaps I ought not, however, from these examinations. to infer that there may not be compact limestone of a great extent made up of different organic remains west of the Rocky mountain."

Again :

"Moses says, the Lord made 'every herb of the field before it grew,' ----'whose seed is in itself,' etc. This accords with the well known fact, that new plants are still springing up from seeds, probably planted at the creation, wherever forests are cut away and other steps taken to prepare particular patches of earth for giving growth to such particular plants. It is even said that pulverized rocks have been known to afford seeds, and to give growth to new plants. Perhaps this latter fact is not well authenticated."

In short, prior to about 1820, but little was known of North American Geology and Palæontology, and except as a matter of historical curiosity, rather than instruction, we need not seek these sciences in earlier publications.

The Mesozoic and Cænozoic rocks, to which this essay will be confined, constitute the superior one fourth part of the geological column, in the sedimentary strata, of the continent; the other three fourths belong to Palæozoic age. As a striking illustration: the upturned palæozoic strata, in the little state of New Hampshire, reveal a thickness twice that furnished by the Mesozoic and Cænozoic rocks throughout their extensive distribution to the remotest parts of the continent.

It will be observed in the sequel, that I have followed the chronological order of discovery, as near as practicable, with a view of presenting the history, the development and the growth of these sciences, as well as the facts, within the scope considered, upon which they are now supposed to rest.

First, we will pursue the Mesozoic rocks and fossils, and afterward the Cænozoic.

THE MESOZOIC AGE.

The Mesozoic age is divided into three periods, beginning with the earliest, as follows:

1. The Triassic Period.
2. The Jurassic Period.
3. The Cretaceous Period.

The name Triassic was given to the 1st Period in allusion to a threefold division, which it presents in Germany. The Jurassic derives its name from the Jura mountains of Switzerland; and the name Cretaceous is derived from *creta*, chalk.

It will be convenient to consider the Triassic and Jurassic together, because the line of separation, at many places, still remains a matter of doubt, and because the rocks at one place, at one time, have been considered as Triassic, and at another as Jurassic, and even now great uncertainty exists as to their correct classification.

TRIASSIC AND JURASSIC.

In 1832, Prof. Edward Hitchcock* described the New Red Sandstone which extends across the State of Massachusetts, on both sides of the Connecticut river.

In 1833,* he referred all the sandstone in the valley of the Connecticut to the age of the New Red Sandstone of Europe. The opinion was

* Geo. of Mass.

fortified by the organic remains which had been collected at that time, as well as by the mineral character of the rocks. He described the rocks as micaceous sandstone, variegated sandstone, brecciated sandstone, shales, argillaceous slate and limestones. He discussed the dip, direction and thickness of the strata, and the occurrence of valuable minerals.

In 1836,* he described, from Massachusetts, *Ornithichnites giganteus*, now *Brontozoum giganteum*, *O. tuberosus*, and *O. tuberosus*, *var. dubius*, now *B. loxonyx*, and *B. sillimanium*, *O. ingens*, now *Tridentipes ingens*, *O. diversus*, now *Tridentipes elegans*, *O. minimus*, now *Argozoum minimum*, *O. palmatus*, and *O. tetradactylus.*

In 1839, Prof. H. D. Rogers† described the Red Sandstone of Pennsylvania, which stretches through the central and northern portions in a long and irregular tract, from New Jersey to Maryland. It is found in the vicinity of Reading, and near the Potomac river, from which place is quarried the famous Red Sandstone used in Washington city. Prof. Rogers proposed to call this the "Middle Secondary Red Sandstone formation," because it is higher than the Coal Measures, and below the Cretaceous Green Sand of New Jersey.

In 1841, W. C. Redfield‡ described, from the Connecticut Valley, *Palæoniscus macropterus*, now *Ischypterus macropterus*, *P. agassizi*, *P. ovatus*, *Catopterus anguilliformis*, *C. parvulus*, and *C. macrurus*, now *Dictyopyge macrura.*

In the same year, Prof. Hitchcock§ said the New Red Sandstone, extending from New Haven to the north line of Mass., in Northfield, occupies a narrow synclinal trough, having a width of about 20 miles, from East Hampton, in Massachusetts, to the Sound at New Haven; but from East Hampton to Northfield a width of only 6 or 7 miles. He described *Fucoides connecticutensis*, *F. shepardi*, *Sauroidichnites barratti*, *S. heteroclitus*, now *Ancyropus heteroclitus*, *S. minitans*, now *Plectropterna minitans*, *S. longipes*, *S. palmatus*, and *S. polemarchus*, now *Polemarchus gigas.* He used the word *Sauroidichnites* as a generic name, but described it as the name of a sub-order under the class *Ichnolite.* He also described *Ornithoidichnites* as a sub-order, and used it as a generic name, and described numerous species under it. These names have, however, been abandoned, and the species have also been abandoned or referred to genera properly defined. The

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* Am. Jour. Sci. and Arts, vol. xxix.

† 3d Ann. Rep., Pa,

‡ Am. Jour. Sci. and Arts, vol. xli.

§ Geo. of Mass.

Ornithoidichnites are *O. giganteus*, *O. tuberosus*, *O. expansus*, *O. cuneatus*, *O. parvulus*, *O. ingens*, *O. elegans*, *O. deani*, *O. tenuis*, *O. macrodactylus*, *O. divaricatus*, *O. isodactylus*, *O. delicatulus*, *O. minimus*, *O. gracilior*, and *O. tetradactylus*. He afterward, before the Association of American Geologists and Naturalists, described some species under these names, which he subsequently referred to other genera.

In 1842, Prof. J. G. Percival* described the existence of these rocks in two places in Connecticut, as follows:

The larger secondary formation extends from Morris Cove, on the east side of New Haven Harbor, on the south, to the north end of Northfield village, in Mass., on the north, a distance of nearly 80 miles. Its greatest width, near the central part of the basin, exceeds 20 miles. This basin is entirely surrounded by Primary rocks, except at New Haven Harbor, where, however, Primary rocks form the two points on the opposite sides of the basin. The smaller secondary formation extends 6 to 7 miles from south to north, and at its widest point scarcely exceeds two miles in breadth, and is about equally included in the towns of Woodbury and Southbury. It forms a small isolated tract, nearly in the center of that part of the Western Primary, within the limits of the State, and nearly 15 miles west of the larger secondary formation. The rocks of both these formations consist of Red Sandstones, Conglomerates and Shales, and the physical characters and organic remains indicate a peculiar relation to the New Red Sandstone of Europe.

In 1843, Prof. W. W. Mather† described these rocks in the State of New York, as follows:

The New Red Sandstone occupies that portion of Rockland county, from Grassy point along the base of the Highlands to New Jersey, and eastward to the Hudson, but a portion of its area is covered over by trap rocks. It has also been found in a small area in Richmond county. In color, it varies from chocolate brown, through brick-red and gray to white; in texture, it varies from pebbly conglomerate, through common sandstone, fissile and micaceous sandstone, to shale; and in composition, from perfectly siliceous to an argillo-calcareous marl. Where the trappean rocks have cut through the strata, or have spread laterally between them, their texture and appearance are much modified, and appear to have been subjected to the action of heat, which has partly melted them, or rendered them more compact and hard, like a hard-burnt brick, or has made them metalliferous.

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* Geo. of Conn. † Geo. of N. Y.

In the same year, Prof. W. B. Rogers* described, from the Trias of Eastern Virginia, *Equisetum arundiniforme*, *Calamites planicostatus*, *Tæniopteris magnifolia*, *Zamites obtusifolius*, and *Z. tenuistriatus.*

In 1847, Sir Charles Lyell† described the Triassic coal field, on the James river, near Richmond, Virginia, as follows: The tract of country occupied by the crystalline or hypogene rocks, which runs parallel to the Alleghany mountains, and on their eastern side is in this part of Virginia about 70 miles broad; in the midst of this space the coal-field occurs in a depression of the granitic and other hypogene rocks, on which the coal rests, and by which it is surrounded, along its outcrop. The length of the coal-field, from north to south, is about 26 miles, and its breadth varies from 4 to 12 miles. The James river flows through the middle of it, about 15 miles from its northern extremity, while the Appomattox traverses it near its southern borders; on its eastern side it is distant about 13 miles from the city of Richmond; it occupies an elliptical area, the beds lying in a trough, the lowest of them usually highly inclined, where they crop out along the margin of the basin, while the strata higher in the series, which appear in the central part of the basin, are very nearly horizontal. The general strike is about N.N.E. and S.S.W., while that of the nearest ridges of the Appalachian chain is about N.E. and S.W.

A great portion of these coal measures consists of quartzose sandstone, and coarse grit, some of the beds, in the lower part of the series resembling granite or syenite, being entirely composed of the detritus of the neighboring granitic and syenitic rocks. Dark carbonaceous shales and clays, occasionally charged with iron ores, abound in the proximity of the coal seams, and numerous impressions of plants, chiefly ferns and zamites, are met with in shales, together with flattened and prostrate stems of Calamites and Equisetum. These last, however, the Calamites and Equisetum, are very commonly met with in a vertical position, more or less compressed perpendicularly. That the greater number of Calamites standing erect in the beds above and between the seams or beds of coal, which I saw at points many miles distant from each other, have grown in the places where they are now buried in sand and mud, I entertain no doubt. This fact would imply the gradual accumulation of the coal measures during a slow and repeated subsidence of the whole region.

The coal seams have hitherto been all found at or near the bottom of the series, and the plants in beds below or between them, or immediate-

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* Trans. Ass. Am. Geo. and Nat.

† Quar. Jour. Geo. Sci., vol. iii.

ly overlying. One or two species of shells (Posidonomya?) also occur in the same part of the series, at a small height above the coal-seams, and above these a great number of fossil fish, chiefly referable to two nearly allied species of a genus, very distinct from any ichthyolite hitherto discovered elsewhere. Above these fossiliferous beds, which probably never exceed 400 or 500 feet in thickness, a great succession of grits, sandstone and shales of unknown depth occur. They have yielded no coal, nor as yet any organic remains, and no speculator has been bold enough to sink a shaft through them, as it is feared that toward the central parts of the basin they might have to pass through 2000 or 2500 feet of sterile measures before reaching the fundamental coal seams.

The coal is separated almost everywhere into three distinct beds, and sometimes into five. The upper bed is the thickest, except in a few places where a thin layer of coal is found above it. In some places the main seam of coal is from 30 to 40 feet thick, and at Blackheath it is seen actually to touch the fundamental granite, or is parted from it only by an inch or two of shale.

A section at the Midlothian Pit, half a mile south of Blackheath, on the eastern outcrop of the coal, is as follows: Sandstone and shale, 570 feet; slate with calamites, 1½ feet; sandstone and shale, 43 10.12 feet; sandstone with calamites, 8 feet; sandstone and slaty shale, 48 feet; slate and long vegetable stems, 2½ feet; sandstone, 6½ feet; slate with calamites, 5½ feet; sandstone, 14 feet; black rock, 13 feet; slate, 5 feet; main coal, 36 feet; sandstone not laminated, 5 feet; slate, 4 feet; coal, 1 foot; slate, 3 feet; sandstone or grit, 7 feet. Total, 773 10-12 feet. This rests upon granite of unknown depth. Some deductions must be made for the thickness of the beds on account of the inclination at an angle of 20 degrees.

The unevenness of the granite floor is extremely great, and the thickness of the coal seams quite variable. The disturbances have been extremely great, and dikes of greenstone occur in some places 20 feet in thickness. Some of the upper beds of coal have been reduced to coke, by being deprived of their volatile matter, while others below remain unaltered and bituminous. This is accounted for on the ground that the greenstone, although intrusive, has made its way between the strata like a conformable deposit, and has driven the gaseous matter from the upper coal, while its influence has not extended to lower seams. A remarkable example of coke, in a bed eight feet in thickness, occurs at Edge-hill, a locality between five and six miles north of James river, and ten miles north of Blackheath, being on the

eastern outcrop of the basin, and within 500 yards of the granite. The measures passed through above the 8 feet bed of coke, are 110 feet thick, including a conformable bed of blue basalt, 16 feet thick. The shale immediately below the trap is white for 11 feet, and then 25 feet of dark, leafy shale succeed, below which comes the bed of coke, resting on white shale; and lower down, coal-measures with two seams of inferior coal, each about 4 or 5 feet thick. The shale, 47 feet thick, interposed between the basalt and the coke, exhibits so many polished surfaces or slickensides, and is so much jointed and cracked, and in some places disturbed and tilted, that we may probably attribute the change from coal to coke, not so much to the heating agency of the intrusive basalt, as to its mechanical effect in breaking up the integrity of the beds, and rendering them permeable to water or the gases of decomposing coal. In some places, in the same district, where the upper part of a seam is coke, the lower is coal, and there is sometimes a gradation from the one to the other, and sometimes a somewhat abrupt separation.

In the same year, C. J. F. Bunbury* described, from North Carolina, *Neuropteris linnæifolia*, *Pecopteris bullata*, *Filicites fimbriatus*, and *Zamites gramineus.* And Prof. Hitchcock† described, from Massachusetts, *Brontozoum moodi*, and *B. parallelum.* He also discussed the Trap Tuff or Volcanic grit of the Connecticut valley, with the bearing of its history upon the Trap Rock and the Red Sandstone.

In 1848, Prof. J. W. Dawson‡ described the New Red Sandstone of Nova Scotia, which extends on the north side of Cobequid bay, from Moose river to the point at the mouth of North river, and on the south side, from the mouth of Shubenacadie to the mouth of North river. It rests upon carboniferous strata, and, in some places, presents cliffs rising to an eminence of 400 feet. It is also extensively developed at Blomidon, in the valley of Cornwallis, on the south side of the Bay of Fundy, and at other places. This sandstone appears to have been deposited in an arm of the sea, somewhat resembling, in its general form, the southern part of the present Bay of Fundy, but rather longer and wider. This ancient bay was bounded by disturbed Carboniferous and Silurian strata. The evidences of volcanic action are numerous, and in some places showing great quantities of melted rock brought to the surface, without altering the soft arenaceous beds through which it has been poured, and whose surface it has

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* Quar. Jour. Geo. Soc., vol. iii.
† Am. Jour. Sci. and Arts. 2d Ser., vol. iv.
‡ Quar. Jour. Geo. Soc., vol. iv.

overflowed. The Sandstone contains no valuable minerals, and no fossils had then been detected in it.

In 1853, Isaac Lea* described, from the Triassic of Lehigh county, Pennsylvania, *Clepsysaurus pennsylvanicus.*

In 1854, Dr. Joseph Leidy† described, from the Triassic of Prince Edward Island, *Bathygnathus borealis.*

In 1855, Prof. J. W. Dawson described Prince Edward Island, which stretches for 125 miles along the northern coast of Nova Scotia and New Brunswick, has everywhere a low, undulating surface, and consists almost entirely of soft red sandstone and arenaceous shale, much resembling the new red of Nova Scotia, and like it having the component particles of the rock united by a calcareous cement. In some places the calcareous matter has been in sufficient abundance to form bands of impure limestone, usually thin and arenaceous. Over the greater part of the island these beds dip at small angles to the northward, with, however, large undulations to the south, which probably cause the same beds to be repeated in the sections on the opposite sides of the island.

In the same year, Dr. E. Hitchcock, jr.‡ described *Clathropteris rectiusculus*, from the sandstone of Mt. Tom, in Easthampton, Mass., of the age of the lower Jurassic.

In 1856, Prof. E. Emmons§ described, from the Lower Triassic of the Deep and Dan river beds of North Carolina, *Chondrites gracilis*, *C. interruptus*, *C. ramosus*, *Gymnocaulus alternatus*, *Equisetum columnaroides*, *Dictuocaulus striatus*, *Rutiodon carolinensis*, *Clepsysaurus leai*, *Palæosaurus carolinensis*, *P. sulcatus* and *Posidonia ovalis*, now referred to the genus *Estheria*, and from the Upper Triassic of the Deep and Dan river beds, *Strangerites obliquus*, *Acrostichites oblongus*, *Pecopteris carolinensis*, *P. falcata*, *Pterozamites decussatus*, *Cycadites acutus*, *C. longifolius*, *Zamites graminioides*, *Podozamites lanceolatus*, *P. longifolius*, *Lepacyclotes circularis*, *L. ellipticus*, *Walchia diffusa*, *W. longifolia*, *Calamites disjunctus*, *Sphenoglossum quadrifolium*, and *Posidonia multicostata*, and *P. triangularis*, which are now regarded as synonyms or varieties only of *Estheria ovalis.*

And in 1857‖ he described, from North Carolina, *Calamites punctatus*, *Walchia angustifolia*, *W. variabilis*, *W. brevifolia*, *W. gracilis*, *Sphenopteris egyptiaca*, *Cyclopteris obscura*, *Odontopteris tenuifolia*,

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* Jour. Acad. Nat. Sci., 2d Ser., vol. ii.

† Jour. Acad. Nat. Sci., 2d Ser. vol. ii.

‡ Am. Jour. Sci. and Arts, 2d Ser., vol. xx.

§ N. Carolina Sur.

‖ Am. Geo., pt. 6.

Pterozamites gracilis, *P. obtusus*, *P. linearis*, *P. spatulatus*, *Dioonites linearis*, *Strangerites planus*, *Pterophyllum robustum*, *Noeggerathia striata*, *Comephyllum*, *cristatum*, *Amblypterus ornatus*, *Rabdiolepis speciosus*, *Microdus lævis*, *Palæonornis struthionoides*, and *Dromatherium silvestre*, the most ancient mammalian remains yet found upon the continent.

In 1857, T. A. Conrad* described, from the Triassic black shale at Phœnixville, Pennsylvania, *Myacites pennsylvanicus*.

In 1858, Meek and Hayden† described, from the Jurassic of the Black Hills, *Pentacrinus asteriscus*, *Lingula brevirostra*, *Avicula tenuicostata*, *Mytilus pertenuis*, *Arca inornata*, now *Grammatodon inornatus*, *Panopæa subelliptica*, now *Myacites subellipticus*, *Ammonites cordiformis*, *A. henryi*, and *Belemnites densus*.

Prof. Hitchcock made his report on the Ichnology of New England, being "A report on the Sandstone of the Connecticut valley, especially its Fossil Footmarks, made to the government of the Commonwealth of Massachusetts." This work contains a bibliography of North American Fossil Footmarks; the history of the discoveries of the tracks; a discussion of the geological position of the Connecticut river sandstone, and the evidences tending to prove the Jurassic Age of at least the upper half of the strata, with geological sections across the valley, showing that in general the dip is easterly, varying fron 5° to 50°.

The sandstone of the Connecticut valley extends from Northfield, in the Northern part of Massachusetts, across the latter State, and Connecticut to Long Island Sound, a distance of 105 miles. The greatest width is at the mouth of the Farmington river, though Hitchcock's Springfield section was taken where the width is nearly as great. Several ranges of trap rock (greenstone, amygdaloid, and volcanic grit), traverse the sandstone longitudinally, having for the most part a northeasterly trend, and being generally in the form of interstratified beds or masses. Along the west side of the valley, there is a coarse, thick-bedded sandstone, whose prevailing color is red, but which is sometimes mottled, and near the trap and the hypozoic rocks, sometimes nearly white. This sandstone underlies the trap. Immediately above the trap, on the east side of the valley, the rocks consist of interstratified red and black shales, volcanic grit, micaceous sandstone, compact, fetid blue and gray limestone, and in some places coarse sandstone and conglomerate. It is in the shales and sandstones lying im-

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* Proc. Acad. Nat. Sci., vol. ix.
† Proc. Acad. Nat. Sci.

mediately above the trap, with very few exceptions, that the organic remains—the fishes, the tracks, and plants—are found. His sections show the thickness of the sandstone above and below the trap, as follows:

	Feet.
Turner's Falls section, above	4,190
" " " below	7,788
Mettawampe section, above	1,584
" " below	5,283
Mount Tom section, above	8,102
" " below	5,115
Agawam and Chicopee or Springfield section, above	11,500
" " " " " " below	8,128

The rock below the trap seems, from the evidences adduced, to be of Triassic Age. He argues that the strata of sandstone were not deposited in their present inclined position, and subsequently elevated, and that the sandstone was not elevated or tilted up by the eruption of the trap rock; but, on the contrary, that the lower beds of sandstone were deposited, and perhaps somewhat tilted up, when the trap was ejected from beneath, and spread over the upper part of the strata, and that afterward the work of depositing the sandstone was resumed, and that which lies above the trap laid down. New outbursts of the trap, however, occurred at subsequent periods, but less in quantity, as if the eruptive force were dying out. This is followed by a very learned essay upon the constant and distinctive characters in the feet of animals, and the application of the rules laid down, to the footmarks, which he described and illustrated. He called these tracks *Lithichnozoa*—stone-track animals; or animals made known by their tracks in stone.

The longest trough, and greatest exposure, in the Eastern States, begins at Stony Point, on the Hudson, and extending across New Jersey, Pennsylvania and Maryland, reaches Culpepper county, in Virginia. It has a length of about 350 miles, and though frequently narrowing to a breadth of four or five miles, it expands, in New Jersey, to a width of about thirty-six miles. The character of the deposit very much resembles that of the Connecticut valley. The other Virginia deposit exists in Henry, Pittsylvania, Halifax, Prince Edward and Buckingham counties.

Prof. Emmons first ascertained the extent and general character of the two basins of Triassic strata, in North Carolina. One is in Stokes and Rockingham counties, bordering on Virginia. It begins at Leaksville, and runs about thirty miles southwest to Germantown, and is from four to six miles wide. The other commences six miles south of Oxford, in Granville county, and runs southwest through a part of

Orange, Chatham, Moore, Montgomery, Richmond and Anson counties, and extends about six miles into South Carolina. Its length is about 120 miles, and it has a breadth, in the widest part, of 18 miles, though its width is generally about six miles.

In 1859, Major Hawn* gave a section in Kansas, of rocks 410 feet in thickness, which he referred to the Triassic. But Dr. Mudge has maintained since that time, that the cretaceous rocks rest directly upon the Permian, in that State.

In 1860, Meek & Hayden† described, from the Jurassic, at the southwest base of the Black Hills, *Pholadomya humilis*, *Myacites nebrascensis*, *Thracia arcuata*, *T. sublævis*, *Cardium shumardi*, *Tancredia æquilateralis*, *T. warrenana*, *Astarte fragilis*, *A. inornata*, *Trigonia conradi*, *Pecten extenuatus*, now *Camptonectes extenuatus*, and from Red Buttes, on the North Platte, *Ostrea engelmanni*, *Pecten bellistriata*, now *Camptonectes bellistriatus*, and *Dentalium subquadratum*.

And Wm. M. Gabb‡ described, from the Triassic in Bath county, Virginia, *Ceratites virginianus* and *Rhynchonella halli*.

In 1861, Dr. F. V. Hayden,§ in his reconnoissance of the country about the headwaters of the Missouri and Yellowstone rivers, found the red arenaceous deposits, usually referred to the Triassic age, exposed in outcropping belts, from one to two miles wide, around the margins of the mountain elevations, but not generally otherwise exposed. They occur on the northeastern side of the Big Horn mountains, on the west slope of the Wind River mountains, along the mountains at the source of the Missouri, around the Judith mountains, and at numerous other places. Frequently thick layers of gypsum are found in the deposits. The thickness observed is from 1000 to 1500 feet.

He also found the Jurassic rocks overlying the red arenaceous beds, referred to the Triassic, and possessing an equal geographical extension. They are found along the margins of the Black Hills, along the northeastern slope of the Big Horn mountains; at Red Buttes; along the southwest side of the Big Horn, and the northeast side of the Wind River mountains, sometimes having a thickness of 1000 feet, and containing organic remains in the greatest abundance.

In the same year, Meek & Hayden‖ described, from the Jurassic, at

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* Proc. Am. Ass. Ad. Sci.
† Proc. Acad. Nat. Sci.
‡ Jour. Acad. Nat. Sci., 2d Ser., vol. iv.
§ Am. Jour. Sci. and Arts, 2d Ser., vol. xxxi.
‖ Proc. Acad. Nat. Sci.

the head of Wind River valley, *Gryphæa calceola*, var. *nebrascensis*, *Modiola formosa*, now *Volsella formosa*, *Neritella nebrascensis*, *Melania veterna*, now *Lioplacodes veterna*.

In 1864, F. B. Meek* described, from the Jurassic, of California, *Rhynchonella gnathophora*, *Lima sinuata*, *L. recticostata*, *L. cuneata*, *Pecten acutiplicatus*, *Inoceramus obliquus*, *I. rectangulus*, *Trigonia pandicosta*, *Mytilus multistriatus*, *Astarte ventricosa*, *Unicardium gibbosum*, *Myacitus depressus*. And W. M. Gabb† described *Lima erringtoni*, now *Aucella erringtoni*, and *Belemnites pacificus*.

And from the Triassic rocks,‡ in the Buena Vista District, and the Humboldt Mining Region of Nevada Territory, *Orthoceras blakei*. *Nautilus whitneyi*, *N. multicameratus*, *Ceratites whitneyi*, *Ammonites blakei*, *A. homfrayi*, *A. billingsanus*, *Myacites humboldtensis*, *Corbula blakei*, *Mytilus homfrayi*, *Avicula homfrayi*, *Halobia dubia*, *Rhynchopterus obesus*, *Posidonomya stella*, *P. daytonensis*, *Myophoria alta*, *Terebratula humboldtensis*, *Rhynchonella lingulata*, *R. æquiplicata*, *Spirifera homfrayi*, from Sonora Mexico, *Panopæa remondi*, from Gifford's Ranch, Plumas county, California, *Avicula mucronata*, *Monotis subcircularis*, *Pecten deformis*.

In 1865, F. B. Meek§ described, from the Jurassic, near the southwest base of the Black Hills, *Viviparus gilli;* from the auriferous slates on the Mariposa estate of California,‖ *Aucella erringtoni*, var. *linguiformis*, and *Amussium aurarium*. J. D. Whitney referred the auriferous rocks of El Dorado, Mariposa, and Toulomme counties, California, to Jurassic or Triassic age. And Bailey and Matthew¶ showed that the Trias of New Brunswick consists of three small patches, on the coast of the Bay of Fundy, one at Quaco Head, another at Gardner's Creek, and the other at Salisbury Cove.

In 1866, Prof. E. D. Cope** described, from the Triassic, at Phœnixville, Pa., *Mastodonsaurus durus*, now *Eupelor durus*, and *Pterodactylus longispinus*.

In 1867, Prof. Swallow†† found, in eastern Kansas, what he supposed to be the Triassic, consisting of a series of buff, red and

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* Pal. of Cal., vol. i.
† Proc. Cal. Acad. Sci.
‡ Pal. of Cal., vol. i.
§ Pal. Up., Mo.
‖ Geo. Sur. Cal., vol. i.
¶ Rep. on S. N. Brunswick.
** Proc. Acad. Nat. Sci.
†† Proc. Am. Ass. Ad. Sci.

mottled sandstones, red and drab marls, buff, magnesian and black limestones, blue and brown shales and gypsum, 344 feet in thickness. These rocks extend in an irregular belt across the State, from the head waters of the Blue and Fancy, across the Republican and Solomon, and over the Kansas, between Turkey Creek and the Saline; thence south and southeasterly up the Smoky Hill and Gypsum, Holland and Turkey Creeks; along the northern slope of the divide, south of the Kansas, to the heads of Lyon and Diamond Creeks; sweeping thence westward across the Cottonwood and down the divide, south of that stream, to the Walnut and White Water. The gypsum beds vary in thickness from 0 to 50 feet, and crop out on the Blue, the Republican, and the Kansas, and on Turkey Creek; and on the divides between the Gypsum and Holland, and between Turkey Creek and the Cottonwood.

In the same year, Dr. F. V. Hayden * referred the celebrated Pipestone quarry of northeastern Dakota, to the Triassic, and showed that the manufacture of it into pipes commenced by the Indians, at a quite recent date—probably within the last 50 or 100 years. The pipestone is called Catlinite.

The Triassic rocks of New Jersey † are included in a belt of country which has the Highland Range of mountains on its northwest side, and a line almost straight from Staten Island Sound, near Woodbridge, to Trenton, on its southeast; the Hudson river on the northeast, and the Delaware on the southwest. The length of the southern border line is 74 miles; that on the northwest is 68 miles. These measurements are from the Delaware river to the State line. Its greatest breadth is on the Delaware, where it is over 30 miles across. From Mine mountain to the Raritan river, near the mouth of Lawrence Brook, its breadth is 19 miles. On the State line, from the Hudson river to Sufferns, it is 15 miles. The area embraced within these limits, excluding the bays, is about 1500 square miles. Of this about 330 square miles are occupied by trap rock. It consists of red sandstone, and is fossiliferous, at Pompton, Boonton, Milford, Tumble Station, Belleville, Newark, Pluckamin and other places.

The ordinary way of computing the thickness of a rock formation is to take its dip, and also the breadth of country across which this dip is continued, and use them as two parts of a right-angled triangle forgetting the remaining parts, one of which is the perpendicular thick-

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* Am. Jour. Sci. and Arts, 2 ser., vol. xliii.
† Geo. of N. Jersey, 1868.

ness of the rock. The red sandstone has an average dip along the Delaware river, of at least 10 degrees, for 30 miles. This would give a thickness of 27,000 feet for this formation, or more than five miles. If the mode of computation is accepted, the result must be received as correct. Those who think the strata were once horizontal, and that they have been thrown into their present inclined position at some later period, adopt this conclusion without hesitation. Others who think the strata were deposited on a slope as we now find them, do not consider the above to be the true thickness. They suppose that the strata along the southeast border were first deposited on this northwest slope; and then that the upper edges were worn off, and the material carried farther northwest to be again deposited, and form new strata upon the lower parts of those already deposited. Without any addition of material there would in this way be a multiplication of strata, all having the same dip. And such a process could go on until the formation had widened out to its present extent.

The aqueous rocks of the new red sandstone period, in Nova Scotia and Prince Edward Island,* are principally coarse and soft red sandstones, with a calcareous cement, which causes them to effervesce with acids, and contributes to the fertility of the soils formed from them. In the low part of the formation, there are conglomerates made up of well-worn pebbles of the harder and older rocks.

The volcanic rocks of this period are of that character known to geologists as trap, and are quite analogous to the products of modern volcanoes; and, like them, consist principally of *Augite*. a dark green or blackish mineral, composed of silica, lime and magnesia, with iron as a coloring material. Various kinds of trap are distinguished, corresponding to the varieties of modern lavas. Crystalline or basaltic trap is a black or dark green rock, of a fine crystalline texture, and having on the large scale a strong tendency, to assume a rude columnar or basaltic structure. Amygdaloid or almond-cake trap is full of round or oval cavities or air bubbles, filled with light colored minerals introduced by water after the formation of the rock. This represents the vesicular or porous lava which forms the upper surface of lava currents, just as the basalt trap represents the basaltiform lava which appears in their lower and more central parts. The only difference is, that in the amygdaloid the cavities are filled up, while in the modern lavas they are empty. In some old lavas, however, the cavities are already wholly or partially filled. A third

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* Acadian Geology, 1868.

kind of trap, very abundant in Nova Scotia, is Tufa or Tuff, or volcanic sandstone, a rock of earthy or sandy appearance, and of gray, greenish or brown color. It consists of fine volcanic dust, and scoriæ, popularly known as the ashes and cinders of volcanoes, cemented together into a somewhat tough rock. Modern tufa, quite analogous to that of the trap, is very abundant in volcanic countries, and sometimes sufficiently hard to be quarried as a stone.

In the valley of the Salmon river, 4½ miles eastward of the village of Truro, the eastern extremity of the New Red Sandstone is seen to rest unconformably on hard, reddish, brown sandstones and shales, belonging to the lower part of the Carboniferous system, and dipping N. 80 degrees, E. at an angle of 40 degrees. At this place the overlying formation is nearly horizontal, and consists of soft and rather coarse, bright, red, silicious sandstones. Southward of Truro, at the distance of less than a mile, the horizontal soft red sandstone is seen in the banks of a brook, to run against hard, brownish grits and shales, dipping to the eastward at angles varying from 45 to 50 degrees. Westward of this place, the red sandstones extend in a narrow band, about a mile in width, to the mouth of the Shubenacadie, ten miles distant. This band is bounded on the North by Cobequid Bay, and on the South by highly inclined sandstone, shale, and limestone of the Lower Carboniferous series. In the coast section, between Truro and the Shubenacadie, the red sandstone presents the same characters as at the former place, except that near the Shubenacadie, some of the beds, which, like most of the red sandstones of Truro, have a calcareous cement, show a tendency to arrangement in large concretionary balls. West of the mouth of the Shubenacadie, the red sandstone ceases to form a continuous belt, but occurs in several patches, especially at Salter's head, Barncote and Walton. At the latter place, it is seen to rest on the edges of sandstones and other rocks of the Lower Carboniferous system, affording a very fine example of that unconformable superposition, which, in Geology, proves the underlying formation to have been elevated and disturbed before the overlying beds were deposited upon it.

Westward of Walton, the estuary of the Avon river and Minas basin make a very wide gap in the new red sandstone. On the western side of Minas basin, however, this formation attains its greatest width and grandest proportions. Blomidon is the eastern extremity of a long band of trappean rocks, forming an elevated ridge, named in the greater part of its length the "North Mountains." This ridge is about 123 miles in length, including two insular portions at its western extremity, and does not exceed five miles in breadth, except near Cape

Blomidon, where a narrow promontory, terminating in Cape Split, extends to the northward. The trap of the North Mountains presents to the Bay of Fundy, a range of high cliffs, and is bounded on the inland side by soft red sandstones, which form a long valley separating the trappean rocks from another and more extensive hilly district, occupied principally by metamorphic slates and granite. The trap has protected the softer sandstones from the waves and tides of the bay, and probably also from older denuding agents; and where it terminates, the shore at once recedes to the southward, forming the western side of the Minas basin, and affording a cross section of the North Mountains and the valley of Cornwallis.

At Cape Blomidon, the cliff, which in some parts is 400 feet in height, is composed of red sandstone surmounted by trap. The sandstone is soft, arranged in beds of various degrees of coarseness, and is variegated by greenish bands and blotches. It contains veins of selenite and fibrous gypsum, the latter usually parallel to the containing beds, but sometimes crossing them obliquely. It dips to the N. W. at an angle of 16 degrees. Resting on the sandstone, and appearing to dip with it to the N. W., is a thick bed of amygdaloidal trap, varying in color from gray to dull red, but in general of grayish tints. It is full of cavities and fissures; and these, as well as its vesicles, are filled or coated with quartz, in different States, and with various zeolites, especially heulandite, analcime, natrolite, stilbite, and apophylite, often in large and beautiful masses of crystals. In its lower part there are some portions which are scarcely vesicular, and often appear to contain quartz sand like that of the subjacent sandstone. Above the beds of amygdaloid is a still thicker stratum of crystalline basaltic trap, having a rude columnar structure.

The columnar trap of Blomidon, in consequence of its hardness and vertical joints, presents a perpendicular wall, extending along the top of the precipice. The amygdaloid beneath, being friable and much fissured, falls away in a slope from the base of this wall, and the sandstone in some places forms a continuation of the slope, or is altogether concealed by the fallen fragments of trap. In other places, the sandstone has been cut into a nearly vertical cliff, above which is a terrace of fragments of amygdaloid.

Northward of Cape Blomidon, the northwesterly dips of the sandstone and trap cause the base of the former to descend to the sea-level, the columnar trap, which here appears to be of increased thickness, still presenting a lofty cliff. Southward of the Cape, on the other hand, the amygdaloid and basalt thin out, until the red sandstones

occupy the whole of the cliff. It thus appears that the trap at Blomidon is a comformable bed, resting on the sandstone, exactly as in some places on the opposite shore.

The coast section between Blomidon and Horton, as seen near Pereau river and Bass creek, and at Starr's Point, Long Island and Bout Island, exhibits red sandstones, with northwest dips at angles of about 15 degrees, and precisely similar in mineral character to those of Blomidon, except that near Bass creek some of them contain layers of small pebbles of quartz, slate, granite and trap. The whole of these sandstones underlie those of Blomidon, and resemble those which occupy the long valley of Cornwallis and the Annapolis river, westward of this section. In this valley, the red sandstone, in consequence of its soft and friable nature, is rarely well exposed, but where observed, it has the same dip as on the coast. The comparatively high level of the sandstone, where it underlies the trap, shows that the present form of this valley is in great part due to denudation.

Commencing at Truro, the New Red Sandstone extends with several interruptions, as far as Cape d'Or. It consists of a narrow strip extending only about three miles from the bay, with occasional masses of trap. At Cape d'Or a great mass of trap rests on slightly inclined red sandstone, and this again on disturbed carboniferous rocks, while, behind and from beneath these last, still older slates rise into mountain ridges. Cape d'Or forms a great salient mass standing out into the bay, and separated from the old slate hills behind, by a valley occupied by the red sandstone and carboniferous shales. It differs from most of the trappean masses in the arrangement of its component parts. The upper part of the cliff consists of amygdaloid and tufa, often of a brownish color, while beneath is a more compact trap, showing a tendency to a columnar structure.

The small patches of New Red Sandstone on the New Brunswick side of the Bay of Fundy, with the deposits in Nova Scotia, show that the depression occupied by the Triassic Bay was of similar form (though somewhat enlarged probably) to that occupied by the present Bay of Fundy.

[To be Continued.]

Note.—The species discussed in the first part of my paper on North American Limnæidæ, in the last number of this Journal, and of which the name was omitted, is the *Bulimnea megasoma*, Say. A. G. W.

LIST OF THE COLEOPTERA OBSERVED IN THE VICINITY OF CINCINNATI.

By Charles Dury.

In presenting this list, a few remarks may be appropriate regarding the habits of some of the species mentioned, and the peculiar localities in which they were found. This vicinity, with its diversified surface and abundant vegetation, is very rich in insects of several orders, and particularly so in Coleoptera. The collections from which the list was taken, were mostly made within a radius of three or four miles around the city, including the Kentucky side of the Ohio river, and in no instance over ten miles away. In addition to the species enumerated, quite a number of new ones have been taken, and several new genera. Prof. J. M. Crawford, Mr. C. G. Siewers, Prof. A. G. Wetherby, Harold B. Wilson, and L. R. Freeman, have added many species to the list. To Dr. Geo. H. Horn, of Philadelphia, I am under great obligations for the determination of many species. To Mr. Henry Ulke, of Washington, D. C., I am also obliged.

Avondale, January 22, 1880.

CICINDELIDÆ.

Cicindela 6-guttata, Fab.
purpurea, Oliv.
generosa, Dej.
tranquebarica, Hb.
repanda, Dej.
cuprascens, Lec.

CARABIDÆ.

Omophron robustum, Horn.
americanum, Dej.
tessellatum, Say.
Elaphrus ruscarius, Say.
Notiophilus semistriatus, Say.
confusus, Lec.
hardyi, Putz.
sibiricus, Mots.
Nebria pallipes, Say.
Calosoma externum, Say.
scrutator, Fab.
wilcoxii, Lec.
sayii, Dej.
calidum, Fab.
Carabus limbatus, Say.
vinctus, Web.
Cychrus stenostomus, Web.
var. Lecontei, Dej.
Cychrus elevatus, Fab.
var. heros, Harr.
andrewsii, Harr.
Pasimachus elongatus, Lec.
punctulatus, Hald.
Scarites substriatus, Hald.
subterraneus, Fabr.
Dyschirius hæmorrhoidalis, Dej.
longulus, Lec.
globulosus, Say.
sphæricollis, Say.
erythrocerus, Lec.
brevispinus, Lec.
Ardistomis viridis, Say.
puncticollis, Putz.
Clivina corvina, Putz.
impressifrons, Lec.
elongata, Rand.
bipustulata, Fabr.
Schizogenius lineolatus, Say.
Brachynus americanus, Lec.
perplexus, Dej.
fumans, Fab.
cordicollis, Dej.
Galerita janus, Fab.
bicolor, Drury.
Panagæus fasciatus, Say.
Casnonia pennsylvanica, Linn.

Leptotrachelus dorsalis, Fabr.
Lachnophorus pubescens, Dej.
Plochionus timidus, Hald.
Loxopeza grandis, Hentz.
atriventris, Say.
Lebia pulchella, Dej.
viridis, Say.
viridipennis, Dej.
ornata, Say.
analis, Dej.
fuscata, Dej.
marginella, Lec.
Dianchomena abdominalis, Chd.
scapularis, Dej.
Aphelogenia fuscata, Lec.
bivitata, Fab.
Tetragonoderus fasciatus, Hald.
Dromius piceus, Dej.
quadricollis, Lec.
Blechrus pusio, Lec.
Aphenes lucidula, Dej.
sinuata, Say.
Cymindis pilosa, Say.
americana.
Callida punctata, Lec.
Coptodera aerata, Dej.
Calathus gregarius, Say.
Platynus caudatus, Lec.
hypolithus, Say.
tenebricosus, Gemm.
marginatus, Chd.
sinuatus, Dej.
viridis, Lec.
melanarius, Dej.
punctiformis, Say.
crenistriatus, Lec.
rubripes, Zimm.
excavatus, Dej.
ferreus, Hald.
ruficornis, Lec.
octopunctatus, Fabr.
placidus, Say.
Olisthopus parmatus, Say.
Loxandrus minor, Chd.
Evarthrus siximpressus, Lec.
americanus, Dej.
sodalis, Lec.
obsoletus, Say.
Pterostichus rostratus, Newm.
honestus, Say.
lachrymosus, Newm.
coracinus, Newm.
stygicus, Say.
permundus, Say.
sayii, Brull.
lucublandus, Say.
Myas coracinus, Say.
Amara avida, Say.
exarata, Dej.
Amara furtiva, Say.
augustata, Say.
impuncticollis, Say.
fallax, Lec.
polita, Lec.
interstitialis, Dej.
cupreolata, Putz.
Dicælus dejeanii, Dej.
purpuratus, Bon.
sculptilis, Say.
furvus, Say.
ovalis, Lec.
elongatus, Dej.
teter, Bon.
reflexus, Lec.
politus, Dej.
Anomoglossus emarginatus, Say.
pusillus, Say.
Chlænius rufipes, Dej.
lithophilus, Say.
sericeus, Forster.
prasinus, Dej.
pennsylvanicus, Say.
solitarius, Say.
tricolor, Dej.
tomentosus, Say.
Atranus pubescens, Dej.
Oodes 14-striatus, Chd.
Geopinus incrassatus, Dej.
Cratacanthus dubius, Beauv.
Agonoderus lineola, Fabr.
partiarius, Say.
indistinctus, Dej.
Anisodactylus rusticus, Dej.
carbonarius, Say.
harrisii, Lec.
agricola, Say.
discoideus, Dej.
baltimorensis, Say.
sericeus, Harr.
Amphasia interstitialis, Say.
Anisotarcis nitidipennis, Lec.
Bradycellus dichrous, Dej.
vulpeculus, Say.
badiipennis, Hald.
rupestris, Say.
parallelus, Chd.
Selenophorus gagatina, Dej.
conjunctus, Say.
Harpalus caliginosus, Fab.
faunus, Say.
pennsylvanicus, Dej.
perbivagus, Say.
nitidulus, Chd.
Stenolophus ochropezus, Say.
Patrobus longicornis, Say.
Bembidium punctatostriatum, Say.
paludosum, Sturm.
inæquale, Say.

Bembidium nitidulum, Dej.
americanum, Dej.
chalceum, Dej.
picipes, Kirby.
cordatum, Lec.
dorsale, Say.
patruele, Dej.
variegatum, Say.
intermedius, Kirby.
versicolor, Lac.
pictum, Lec.
affine, Say.
quadrimaculatum, Linn.
lævigatum, Say.
Tachys scitulus, Lec.
nanus, Gyll.
flavicauda, Say.
incurvus, Say.
tripunctatus, Say.
Pericompsus ephippiatus, Say.

HALIPLIDÆ.

Haliplus punctata, Aube.
ruficollis, Dej.
Cnemidotus 12-punctatus, Say.
edentulus, Lec.

DYTISCIDÆ.

Hydrovatus cuspidatus, Germ.
Hydroporus acaroides, Lec.
turbidus, Lec.
nubilus, Lec.
lacustrus, Say.
affinus, Say.
consimilis, Lec.
concinnus, Lec.
Hydrocanthus iricolor, Say.
Cybister fimbriolatus, Say.
Laccophilus maculosus, Germ.
fasciatus, Aube.
proximus, Say.
Acilus semisulcatus, Aube.
fraternus, Harr.
Thermonectes basilaris, Harr.
Hydaticus bimarginatus, Say.
Dytiscus marginicollis, Lec.
cordieri, Aube.
hybridus, Aube.
fasciventris, Say.
Ilibius biguttulus, Germ.
Coptotomus interrogatus, Fab.
Copelatus glyphicus, Say.
Gaurodytes tæniolatus, Harr.
semivittatus, Lec.
stagninus, Say.

GYRINIDÆ.

Dineutes discolor, Aube.
Dineutes assimilis, Aube.
Gyrinus lugens, Lec.
analis, Say.

HYDROPHILIDÆ.

Helophorus lineatus, Say.
Hydrophilus ovatus, H. & G.
triangularis, Say.
Tropisternus nimbatus, Say.
striolatus, Lec.
glaber, Hbst.
mixtus, Lec.
Berosus pantherinus, Lec.
peregrinus, Hbst.
striatus, Say.
Laccobius agilis, Rand.
Philhydrus nebulosus, Say.
ocraceus. Mels.
maculicollis, Muls.
Hydrobius subcupreus, Say.
Cercyon prætextum, Say.

TRICHOPTERYGIDÆ.

Trichopteryx haldemanni, Lec.

STAPHYLINIDÆ.

Falagria cingulata, Lec.
bilobata, Say.
Hamalota trimaculata, Er.
lividipennis, Mann.
Alæochara lata, Grav.
fuscipes, Fab.
Coproporus ventriculus, Grav.
Tachinus fumipennis, Say.
fimbriatus, Grav
limbatus, Mels.
canadensis, Horn.
swartzii, Horn.
Tacyporus jocosus, Say
brunneus, Fabr
nanus, Er.
scitulus.
chrysomelinus, Linn.
maculipennis, Lec.
Conosoma crassum, Grav.
basale, Er.
scriptum, Horn.
littoreum, Linn.
Boletobius niger, Grav.
cincticollis, Say.
cinctus, Grav.
trinotatus.
intrusus, Horn.
dimidiatus, Er.
Bryoporus flavipes, Lec.
Mycetoporus lucidulus, Lec.
Acylophorus flavicollis, Sch.

Quedius fulgidus, Fabr.
capuchinus, Grav.
molochinus, Grav.
sublimbatus, Mots.
peregrinus, Grav.
Creophilus villosus, Grav.
Listotrophus cingulatus, Grav.
Staphylinus maculosus, Grav.
mysticus, Er.
vulpinus, Nord.
tomentosus, Grav.
cinnamopterus, Grav.
violaceus, Grav.
femoratus, Grav.
Ocypus ater, Grav.
Belonuchus formosus, Grav.
Philonthus cyanipennis, Fab.
æneus, Rossi.
blandus, Grav.
brevis, Mels.
debilis, Grav.
palliatus, Grav.
lomatus, Er.
brunneus, Grav.
fusiformis, Mels.
horni.
confertus, Lec.
baltimorensis, Grav.
apicalis, Say.
sobrinus, Er.
terminalis, Lec.
Xantholinus cephalus, Say.
emmesus, Grav.
obscurus.
Leptolinus ruficollis, Lec.
dimidiatum.
umbripennis.
Diochus schaumii, Kr.
Lathrobium punctulatum, Lec.
armatum, Say.
longiusculum, Grav.
collare, Er.
dimidiatum, Say.
Cryptobium badium, Grav.
bicolor, Grav.
pallipes, Grav.
latebricola, Nord.
texanum.
Stilicus tristus, Mels.
augularis, Er.
dentatus, Say.
opacus, Lec.
Lithocharis corticina, Grav.
confluens, Say.
Sunuis linearis, Er.
longiusculus, Mann.
Pæderus littorarius, Grav.
Pinophilus latipes, Er.
Palaminus testaceus, Er.
Stenus comma, Lec.
flavicornis, Er.
Megalops cælatus, Grav.
Oxyporus major, Grav.
femoralis, Grav.
stygicus, Say.
lateralis, Grav.
Osoruis latipes, Grav.
Bledius semiferrugineus, Lec.
emarginatus, Say.
anilis, Lec.
Oxytelus, sculptus, Grav.
insignitus, Grav.
Anthophagus brunneus, Say.
Lesteva biguttula, Lec.
pallipes, Lec.
Pactoglypta lucida, Gyll.
Olophrum rotundicolle, Say.
obtectum.
Lathrimæum sordidum, Er.
Trigonodemus striatus, Lec.
Protinus parvulus, Lec.
Megarthrus excisus, Lec.
Siagonium americanum, Mels.
Glyptoma costale, Er.

PSLAPHIDÆ.

Ceophyllus monilis, Lec.
Cedius ziegleri, Lec.
spinosus, Lec.
Tmesiphorus costalus, Lec.
Ctenistes piceus, Lec.
zimmermanii, Lec.
Tyrus humeralis, Aube.
Tychus minor, Lec.
conjuncta, Lec.
Bryaxis illinoiensis, Brend.
abdominalis, Aube.
rubicunda, Aube.
Batrisus confinis, Lec.
monstrosus, Lec.
spretus, Lec.
Euplectus linearis, Lec.
Faronus tolulæ. Lec.
Rhexius insculptus, Lec.

SILPHIDÆ.

Necrophorus marginata, Fab.
sayii, Lap.
americana, Oliv.
orbicollis, Say.
tomentosus, Web.
Silpha surinamensis, Fab.
noveboracensis, Forst.
inæqualis, Fab.
americana, Linn.
Necrophilus subterraneus, Dahl.

Choleva opaca, Say.
Ptomaphagus consobrinus, Lec.
Catops simplex, Say.
Liodes polita, Lec.
discolor, Mels.
basilis, Lec.
Agathidium oniscoides, Beauv.

SCYDMÆNIDÆ.

Scydmænus fossiger, Lec.
analis, Lec.
clavipes, Say.
salinator, Lec.
Lecontei.
Cephennium corporosum, Lec.

CORYLOPHIDÆ.

Sericoderus flavidus, Lec.
Sacium obscurum, Lec.
amabile, Lec.

SCAPHIDIIDÆ.

Scaphidium obliteratum, Lec.
quadriguttatum, Say.
quadripustulatum, Say.
piceum, Mels.
Scaphisoma convexum, Say.
terminatum, Mels.
Toxidium compressum, Zimm.

DERODONTIDÆ.

Derodontus maculatus, Mels.

LATRIDIIDÆ.

Corticaria americanus, Mannh.

DERMESTIDÆ.

Dermestes marmoratus, Say.
nubilis, Say.
lardarius, Linn.
maculatus, Dej.
Attagenus megatoma, Fab.
Trogoderma ornata, Say.
pallipes, Ziegl.
Anthrenus varius, Fabr.
musæorum, Linn.
Orphilus ater, Er.

ENDOMYCHIDÆ.

Lycoperdina ferruginea, Lec.
Mycetina perpulchra, Newm.
vittata, Fab.
Endomychus biguttatus, Say.
Rhanis unicolor, Ziegl.
Phymaphora pulchella, Newm.
Mycetæa fuscula.
Rhymbus ulkei, Cr.

TRITOMIDÆ.

Mycetophagus punctatus, Say.
flexuosus, Say.
melsheimeri, Lec.
pluripunctatus, Lec.
Triphyllus humeralis, Kirby.
Litargus tetraspilotus, Lec.
6-punctatus, Say.
didesmus, Say.
nebulosus, Lec.
Typhœa fumata, Linn.

CIOIDÆ.

Cis fuscipes, Mell.
Ceracis sallei, Mull.

EROTYLIDÆ.

Languria mozardi, Latr.
augustata, Beauv.
trifasciata, Say.
gracilis, Newm.
Dacne 4-maculata, Say.
Megalodacne fasciata, Fab.
heros, Say.
ulkei, Cr.
Hypodacne punctata, Lec.
Ischyrus 4-punctatus, Oliv.
Mycotretus sanguinipennis, Say.
pulchra, Say.
Tritoma humeralis, Fab.
biguttata, Say.
unicolor, Say.
Triplax festiva, Lec.
macra, Lec.
thoracica, Say.
flavicollis, Lac.

ATOMARIIDÆ.

Antherophagus ochraceus, Mels.
Tomarus pulchellus, Lec.
Atomaria ephippiata, Zimm.
Diplocœlus brunneus, Lec.
Silvanus advena, Waltl.
surinamensis, Linn.
bidentatus, Fabr.
imbellus, Lec.
Nausibius dentatus, Msh.
Telephanes velox, Hald.

CUCUJIDÆ.

Catogenus rufus, Fabr.

Cucujus clavipes, Fabr.
Lamophlæus biguttatus, Say.
fasciatus, Mels.
testaceus, Fab.
Brontes dubius, Fabr.
debilis, Lec.

DITOMIDÆ.

Lyctus striatus, Mels.
opaculus, Lec.
Trogoxylon parallelolopipedum, [Mels.

COLYDIIDÆ.

Coxelus guttulatus, Lec.
Ditoma quadriguttata, Say.
Eudesma undulata, Mels.
Synchita granulata, Say.
parvula, Guer.
fuliginosa.
Cicones marginalis, Mels.
Aulonium parallelopipedum, Say.
Colydium lineola, Say.
Bothrideres gemminatus, Say.
exaratus, Mels.
Philothermus glabriculus, Lec.
castaneum, Say.
Mychocerus depressus, Lec.

RHYSSODIDÆ.

Rhyssodes exaratus, Ill.
Clinidium conjungens, Germ.

RHIZOPHAGIDÆ.

Rhizophagus bipunctatus, Say.
Bactridium striolatum, Reitter.
ephippigerum, Reitter.
Hesperobaenus rufipes, Lec.
Monotoma picipes, Hb.
americana, Aube.

TRAGOSITIDÆ.

Alindria cylindrica, Serv.
Tenebrioides mauritanica, Linn.
corticalis, Mels.
dubia, Horn.
marginata, Beauv.
castanea, Mels.
bimaculata, Mels.
Grynocharis 4-lineata, Mels.

NITIDULIDÆ.

Trixagus unicolor, Say.
Cercus abdominalis, Er.
Colastes maculatus, Er.
morio, Er.
semitectus, Say.
truncatus, Rand.
brachypterus, Say.
Carpophilus niger, Say.
antiquus, Mels.
corticinus, Er.
mutilatus, Fab.
Epuræa hornii, Cr.
rufida, Mels.
corticina, Er.
labilis, Er.
avara, Rand.
rufa, Say.
fulvescens, Horn.
erichsonii.
Conotelus obscurus, Er.
Nitidula bipustulata, Linn.
ziz zac, Say.
Stelidota strigosa, Sch.
Prometopia 6-maculata, Say.
Libiopa undulata, Say.
Osmosita colon, Linn.
Phenolia grossa, Fab.
Meligethes ruficornis, Lec.
Pocadius helvolus, Er.
Amphicrossus ciliatus, Ol.
Pallodes silaceus, Er.
Cryptarcha ampla, Er.
concinna, Mels.
Ips fasciatus, Oliv.
sanguinolentus, oliv.
confluentus, oliv.

PHALACRIDÆ.

Phalacrus politus, Mels.
Olibrus striatulus, Lec.
nitidus, Mels.
ergoti, Walsh.
consimilis.

COCCINELLIDÆ.

Epilachna borealis, Fab.
Megilla maculata, De G.
Hippodamia convergens, Guer.
13-punctata, Linn.
parenthesis, Say.
Coccinella 9-notata, Hb.
Cycloneda sanguinea, Linn.
Adalia bipunctata, Linn.
Anatis 15-punctata, Oliv.
Psyllobora 20-maculata, Say.
Chilocorus bivulnerus, Muls.
Brachyacantha ursina, Fab.
10-pustulata, Mels.
4-punctata, Mels.

Hyperaspis fimbriolatus, Mels.
signata, Oliv.
bigeminata, Rand.
undulata, Say.
elegans, Lec.
proba, Say.
Scymnus bioculatus, Muls.
terminatus, Say.
americanus, Muls.
hæmorrhous, Lec.
caudalis, Lec.
tenebrosus, Muls.

CISTELIDÆ.

Nosodendron unicolor, Say.

PARNIDÆ.

Helichus lithophilus, Germ.
fastigiatus, Say.

HETEROCERIDÆ.

Heterocerus auromicans, Kies.
substriatus, Kies.
collaris, Kies.
pusillus, Say.

HISTERIDÆ.

Hololepta lucida, Lec.
fossularis, Say.
Hister cœnosus, Er.
abbreviatus, Fab.
incertus, Mars.
servus, Er.
subrotundus, Say.
americanus, Payk.
vernes, Say.
carolinus, Payk.
lecontei, Mars.
aurelianus, Horn.
gracilis, Lec
Epieris regularis, Beauv.
pulicarius, Er.
Tribalus americanus, Lec.
Paromalus aequalis, Say.
estriatus, Lec.
bistriatus, Er.
seminulum, Er.
Saprinus lugens, Er.
assimilis, Payk.
vestitus, Lec.
Teretrius americanus, Lec.

LUCANIDÆ.

Lucanus elaphus, Fabr.
Lucanus dama, Thumb.
placidus, Say.
Dorcus parallelus, Say.
Platycerus quercus, Webr.
Ceruchus piceus, Webr.
Passalus cornutus, Fabr.

SCARABÆIDÆ.

Canthon viridis, Beauv.
hudsonias, Forst.
Chœridium histeroides, Web.
Copris carolina, Linn.
anaglypticus, Say.
minutus, Dr.
Phanæus carnifex, Linn.
nigrocyaneus, McLeay.
Onthophagus pennsylvanicus, Born.
hecate, Panz.
janus, Panz.
Aphodius fimetarius, Linn.
granarius, Linn.
inquinatus, Hb.
rubeolus, Beauv.
stercorrosus, Horn.
terminalis, Say.
bicolor, Say.
femoralis, Say.
Dialytes striatulus, Say.
Atænius gracilis, Mels.
stercorator, Fab.
abditus, Hald.
Bolboceras farctus, Fabr.
lazrus, Fabr.
Odontæus cornigerus, Mels.
Geotrypes splendidus, Fab.
semiopacus, Jek.
blackburnii, Fab.
Acanthocerus æneus, McLeay.
Clœotus aphodioides, Ill.
Trox suberosus, Fab.
erinaceus, Lec.
terrestris, Say.
æqualis, Say.
unistriatus, Beauv.
monachus.
Hoplia modesta, Hald.
Dichelonycha fuscula, Lec.
Serica vespertina, Schœn.
iricolor, Say.
sericea, Ill.
Macrodactylus subspinosus, Fabr.
Diplotaxis harperi, Blanch.
Endrosa quercus, Knoch.
Phyllophaga frontalis, Lec.
burmeisteri, Lec.
futilis, Lec.
fusca, Frohl.
lugubris, Lec.

Phyllophaga fraterna, Harr.
crassissima, Blanch.
rugosa, Mels.
ilicis, Knoch.
villifrons, Lec.
rutiola, Lec.
crenulata, Frœhl.
tristis, Fabr.
Anomala varians, Fab.
minuta, Burm.
marginata, Fabr.
lucicola, Fabr.
binotata, Gyll.
Strigoderma arboricola, Fab.
Pelidnota punctata, Linn.
Cotalpa lanigera, Linn.
Cyclocephala villosa, Burm.
Chalepus trachypygus, Burm.
Ligyrus gibbosus, DeGeer.
Aphonus pyriformis, Lec.
tridentatus, Say.
Xyloryctes satyrus, Fabr.
Dynastes tityus, Linn.
Phileurus valgus, Fabr.
Allorhina nitida, Linn.
Euphoria (Euryomia) sepulchralis, [Fabr.
inda, Linn.
fulgida, Fabr.
Cremastochilus knochii, Lec.
Osmoderma eremicola, Knoch.
scabra, Beauv.
Trichius bibens, Fabr.
piger, Fab.
affinis, Gory.
Valgus canaliculatus, Fabr.
squamiger, Beauv.

BUPRESTIDÆ.

Chalcophora campestris, Say.
Dicerca divaricata, Say.
obscura, Fab.
Buprestis, rufipes, Ol.
lauta, Lec.
Cinura gracilipes, Mels.
Melanophila longipes, Say.
Anthaxia cyanella, Gory.
viridicornis, Say.
viridifrons, Gory.
Chrysobothris femorata, Lec.
floricola, Gory.
6-signata, Say.
chrysoela, Ill.
Actenodes acornis, Say.
Acmæodera pulchella, Hbst.
ornata, Fab.
culta, Web.
Ptosima gibbicollis, Say.
Agrilus ruficollis, Fab.
Argilus fulgens, Lec.
bilineatus, Web.
lecontei, Saund.
fallax, Say.
interruptus, Lec.
acutipennis, Mann.
politus, Say.
pubiventris, Cr.
egenus, Gory.
Taprocerus gracilis, Say.
Brachys ovata, Web.
aerosa, Mels.
aeruginosa, Gory.
Pachyscelus lævigatus, Say.

THROSCIDÆ.

Throscus chevrolati, Bouv.
punctatus, Bouv.
Drapetes geminatus, Say.
4-pustulatus, Bouv.

ELATERIDÆ.

Melasis pectinicornis, Mels.
Tharops obliquus, Say.
Stethon pectorosus, Lec.
Deltometopus amoenicornis, Say.
Dromæolus cylindricollis, Say.
striatus, Lec.
Fornax calceatus, Say.
hornii, Bv.
orchesides, Newm.
Microrrhagus humeralis, Say.
subsinuatus, Lec.
Nematodes atropos, Say.
penetrans, Lec.
Perothrops mucida, Gyll.
Adelocera avita, Say.
impressicollis, Say.
discoidea, Web.
aurorata, Say.
marmorata, Fabr.
obtecta, Say.
Chalcolepidius viridipilis, Say.
Alaus oculatus, Linn.
Cardiophorus convexulus, Lec.
Horistonotus curiatus, Say.
Cryptohypnus pulchellus, Linn.
pectoralis, Say.
obliquatulus, Mels.
perplexus, Horn.
Odostethus femoralis, Lec.
Elater rubricollis, Hbst.
nigricollis, Hbst.
linteus, Say.
impolitus, Mels.
hepaticus, Mels.
pedalis, Caud.

Elater pullus, Cand.
collaris, Say.
obliquus, Say.
areolatus, Say.
Drasterius dorsalis, Say.
Monocrepidius lividus, Dej.
suturalis, Lec.
vespertinus, Fabr.
auritus, Hbst.
bellus, Say.
Ischiodontus soleatus, Say.
Ludius abruptus, Say.
attenuatus, Say.
Orthostethus infuscatus, Germ.
Agriotes oblongicollis, Mels.
Glyphonyx recticollis, Say.
testaceus. Mels.
Malanotus corticinus, Say.
macer, Lec.
cuneatus, Lec.
castanipes, Payk.
fissilis, Say.
communis, Gyll.
exuberans, Lec.
parumpunctatus, Mels.
verebrans, Lec.
paganus, Cand.
pertinax, Say.
americanus, Hbst.
tenellus, Er.
morosus, Cand.
sagittarius, Lec.
Limonius griseus, Beauv.
confusus, Lec.
quercinus, Say.
ectypus, Say.
Campylus denticornis, Kirby.
Athous brightwelli, Kirby.
acanthus, Say.
maculicollis, Lec.
scapularis, Say.
posticus, Mels.
reflexus, Lec.
bicolor, Lec.
Bladus quadricollis, Say.
Nothodes dubitans, Lec.
Sericosomus silaceus, Say.
incongruus, Lec.
flavipennis, Mot.
tesselatus, Linn.
Corymbites cylindriformis, Hbst.
divaricatus, Lec.
pyrrhos, Hbst.
bivittatus, Mels.
tarsalus, Mels.
sulcicollis, Say.
aethiops, Hbst.
inflatus, Say.
Asaphus memnonius, Hbst.
Asaphus decoloratus, Say.
bilobatus, Say.
planatus, Lec.
brevicollis, Cand.
Melanactes piceus, DeG.

RHIPICERIDÆ.

Zenoa picea, Beauv.
Sandalus niger, Knoch.

DASCYLLIDÆ.

Ectopria nervosa, Mels.
Cyphon ruficollis, Say.
bicolor, Lec.
Prionocyphon discoideus, Say.
Helodes fuscipennis, Guer.
thoracica, Guer.
Eucinetus terminalis, Lec.
Ptilodactyla elaterina, Guer.

LAMPYRIDÆ.

Dictyoptera perfaceta, Say.
Calopteron typicum, Newm.
retiulatum, Fabr.
Eros coccinatus, Say.
thoracicus, Rand.
sculptilis, Say.
modestus, Say.
floralis, Mels.
Calyptocephalus bifarius, Say.
Lucidota atra, Fabr.
Photinus corruscus, Linn.
autumnalis, Mels.
lacustris, Lec.
nigricans, Say.
borealis, Rand.
augustatus, Lec.
pyralis, Linn.
scintillans, Say.
Photurus pennsylvanica, DeG.
frontalis, Lec.

TELEPHORIDÆ.

Chauliognathus americanus, Forst.
marginatus, Fabr.
Omethes marginatus, Lec.
Podabrus tricostatus, Say.
basilaris, Say.
modestus, Say.
tomentosus, Say.
fayii, Lec.
lævicollis, Kirby.
dentiger, Lec.
Telephorus excavatus, Lec.
carolinus, Fabr.

Telephorus lineola, Fabr.
imbecillis, Lec.
flavipes, Lec.
pusillus, Lec.
fraxini, Say.
bilineatus, Say.
Silis percomis, Say.
Trypherus latipennis, Germ.
Loberus abdominalis, Lec.
Malthinus occipitalis, Lec.

MALACHIDÆ.

Collops 4-maculatus, Fabr.
Anthocomus flavilabris, Say.
Pseudebæus bicolor, Lec.
Attalus morulus, Lec.
humeralis, Lec.
scincetus, Say.
Melyris cribratus, Lec.

CLERIDÆ.

Elasmocerus terminatus, Say.
Cymatodera brunnea, Mels.
bicolor, Say.
undulata, Say.
Priocera castanea, Newm.
Clerus rosmarus, Say.
nigripes, Say.
analis, Lec.
thoracicus, Oliv.
sanguineus, Say.
ichneumoneus, Fabr.
Hydnocera tabida, Lec.
virticalis, Say.
longicollis, Ziegl.
Phyllobænus dislocatus, Say.
Charissa pilosa, Forst.
Cregya oculata, Say.
mixta, Lec.
Orthopleura damicornis, Fabr.
Corynetes rufipes, Fabr.
violaceus, Linn.

LYMEXYLIDÆ.

Hylecoetus americanus, Harr.

PTINIDÆ.

Ptinus fur, Linn.
brunneus, Duf.
Eucrada humeralis, Mels.
Oligomerus sericans, Mels.
Sitodrepa panicea, Linn.
Trichodesma gibbosa, Say.
Hadrobregmus carinatus, Say.
linearis, Lec.
Anobium notatum, Say.
Tripopitys sericeus, Say.
Xletinus peltatus, Harr.
Hemiptychus gravis, Lec.
ventralus, Lec.
Dorcatoma setulosum, Lec.
Ptilinus ruficornis, Say.
thoracicus, Rand.
Sinoxylon declive, Lec.
Bostrychus bicornis, Web.
truncaticollis, Lec.
Amphicerus bicaudatus, Say.
Dinoderus cribratus, Lec.

SPONDYLIDÆ.

Parandra brunnea, Fab.
polita, Say.

CERAMBYCIDÆ.

Orthosoma brunneum, Forst.
Prionis laticollis, Drury.
Sphenostethus taslei, Bug.
Asemum moestum, Hald.
Smodicum cucujiforme, Say.
Phymatodes amoenus, Say.
Callidium antennatum, Newm.
janthinum, Lec.
Dryobius sexfasciatus, Say.
Chion cinctus, Drury.
garganicus, Fab.
Eburia quadrigemminata, Say.
Elaphidion atomarium, Drury.
mucronatum, Fab.
parallelum, Newm.
moestum, Lec.
Tylonotus bimaculatus, Hald.
Phyton pallidum, Say.
Callimoxys sanguinicollis, Oliv.
Molorchus bimaculatus, Say.
Cyllene pictus, Drury.
robiniæ, Forst.
Arhopalus fulminans, Fab.
Xylotrechus colonus, Fab.
Neoclytus scutellaris, Oliv.
erythrocephalus, Fabr.
Clytanthus ruricola, Oliv.
Cyrtophorus verrucosus, Oliv.
Euderces picipes, Fab.
Distenia undata, Oliv.
Centrodera sublineata, Lec.
Toxotus schaumii, Lec.
cylindricollis, Say.
cinnamopterus, Rand.
Acmæops trivittata, Say.
Gaurotes cyanipennis, Say.
Strangalia famelica, Newm.
luteicornis, Fab.
bicolor, Swed.

Typocerus velutinus, Oliv.
Leptura emarginata, Fab.
lineola, Say.
chalybæa, Hald.
hæmatites, Lec.
ruficeps, Lec.
vittata, Germ.
sphæricollis, Say.
vibex, Newm.
Cyrtinus pygmæus, Hald.
Psenocerus supernotatus, Say.
Monohammus maculosus, Hald.
confusor, Kirby.
Dorchaschema wildii, Uhler.
alternatum, Say.
Hetoemis cinerea, Oliv.
Goes pulcher, Hald.
oculatus, Lec.
Acanthoderes quadrigibbus, Say.
decipiens, Hald.
Leptostylus aculifer, Say.
parvus, Lec.
commixtus, Hald.
macula, Say.
Sternidius variegatus, Hald.
alpha, Say.
cinereus, Lec.
xanthoxyli, Shim.
Liopus signatus, Lec.
querci, Fitch.
facetus, Say.
Lepturges angulatus, Hald.
symmetricus, Hald.
Graptisurus fasciatus, DeG.
Acanthocinus obliquus, Lec.
Dectes spinosa, Say.
Ecyrus dasycerus, Say.
exiguus, Lec.
Eupogonius vestitus, Say.
subarmatus, Lec.
Hippopsis lemniscata, Fab.
Saperda calcarata, Say.
candida, Fab.
vestita, Say.
tridentata, Oliv.
moesta, Lec.
Oberea ruficollis, Fab.
mandarina, Fab.
tripunctata, Fab.
basalis, Lec.
Tetraopes cantercator, Drap.
tetraopthalmus, Forst.

SPERMOPHAGIDÆ.

Spermophagus robiniæ, Schh.
Bruchus pisi, Linn.
mimus, Say.
discoideus, Say.
Bruchus bivulneratus, Horn.
cruentatus, Horn.
hibisci, Oliv.
musculus, Say.

CHRYSOMELIDÆ.

Orsodacna atra, Ahr.
Syneta ferruginea, Germ.
Lema brunnicollis, Lac.
trilineata, Oliv.
Anomoea laticlavia, Forst.
Babia 4-guttata, Oliv.
Saxinis omogera, Lac.
Coscinoptera dominicana, Fab.
mucorea, Cr.
Exema gibber, Oliv.
dispar, Lec.
Monachus saponatus, Fab.
Cryptocephalus mammifer, Newm.
lituratus, Fab.
lativittis, Germ.
venustus, Fab.
guttulatus, Oliv.
badius, Suffr.
dispersus, Hald.
4-maculatus, Say.
4-guttulus, Suffr.
quadruplex, Newm.
auratus, Fab.
clorizans, Suffr.
pallidicornis, Suffr.
Pachybrachys viduatus, Fab.
trinotatus, Mels.
sub-fasciatus, Hald.
atomarius, Mels.
infaustus, Hald.
tridens, Mels.
hepaticus, mels.
Fidia murina, Cr.
longipes, Mels.
Xanthonia 10-notata, Say.
Heteraspis nebulosus, Lec.
Glyptoscelis barbatus, Say.
Myochrous denticollis, Say.
Chrysochus auratus, Fab.
Paria 6-notata, Say.
4-notata, Say.
alterrima, Oliv.
viridicyanea, Cr.
Metachroma pallida, Say.
Colaspis flavida, Say.
prætexta, Say.
tristis, Oliv.
convexa, Say.
puncticollis, Say.
Chrysimela clivicollis, Say.
10-lineata, Say.
juncta, Germ.

Chrysomela suturalis, Fabr.
similis, Rog.
præcelsis, Rog.
elegans, Oliv.
multiguttis, Stal.
bigsbyana, Kirby.
Gastrophysa cyanea, Muls.
polygoni, Linn.
caesia, Rog.
Phyllodecta vulgatissima, Linn.
Plagiodera lapponica, Linn.
scripta, Fabr.
Cerotoma caminea, Fabr.
Phyllobrotica discoidea, Fab.
Phyllechthrus gentilis, Lec.
Diabrotica 12-punctata, Oliv.
Galeruca externa, Say.
Galerucella tuberculata, Say.
sagittariæ, Gyll.
notulata, Fab.
Hypolampsis pilosa, Ill.
Oedionychis gibbitarsis, Say.
vians, Ill.
thoracica, Fab.
thyamoides, Cr.
6-maculata, Ill.
Disonycha alternata, Ill.
punctigera, Lec.
glabrata, Fab.
abbreviata, Mels.
discoidea, Fab.
collaris, Fab.
collata, Fab.
Graptodera chalybea, Ill.
fuscoænea.
Longitarsus rubidus, Lec.
Plectroclis denticulata, Lec.
Orchestris vittata, Fab.
bipustulata, Fab.
Systena hudsonias, Forst.
Orthaltica copalina, Fab.
Haltica burgessi, Cr.
Crepidodera rufipes, Linn.
hexalines, Linn.
scabricula, Cr.
atriventris, Mels.
Epitrix fuscula, Cr.
hirtipenins, Mels.
cucumeris, Harr.
Mantura floridana, Cr.
Cerataltica insolita, Mels.
Chætocnema denticulata, Ill.
Psylliodes interstitialis, Lec.
Stenispa metalica, Fab.
Odontota scutellaris, Oliv.
rubra, Web.
rosea, Web.
inæqualis, Web.
Microrhopala porcata, Mels.
Cassida bivittata, Say.
Coptocycla aurichalcea, Fab.
guttata, Oliv.
clavata, Fab.

TENEBRIONIDÆ.

Nyctobates pennsylvanica, DeG.
barbata, Knoch.
Iphthimus opacus, Lec.
Merinus lævis, Oliv.
Haplandrus femoratus, Fab.
Centronopus calcaratus, Fab.
Xlopinus saperdioides, Oliv.
Tenebrio obscurus, Fab.
molitor, Linn.
castaneus, Knoch.
tenebrioides, Beauv.
Sitophagus pallidus, Say.
Apatrinus acciculatus, Lec.
Tribolium ferrugineum, Fab.
Dioedus punctatus, Lec.
Echocerus maxillosus, Fab.
Uloma impressa, Mels.
imberbis, Lec.
Eutochia picea, Mels.
Paratenetus punctatus, Sol.
Diaperis hydni, Fab.
Hoplocephala bicornis, Oliv.
Platydema excavatum, Say.
ruficorne Sturm.
ellipticum, Fab.
americanum, Lap.
sub-costatum, Lap.
Hypophloeus thoracicus, Mels.
Pentaphyllus pallidus, Lec.
Bolilotherus bifurcus, Fab.
Helops micans, Fab.
cisteloides, Germ.
Meracantha contracta, Beauv.
Strongylium terminatum, Say.

ALLECULIDÆ.

Allecula nigrans, Mels.
Hymenorus obscurus, Say.
communis, Lec.
niger, Mels.
Cistela marginata, Ziegl.
sericea, Say.
Isomira quadristriata, Coup.
Mycetochares haldemani, Lec.
fraterna, Say.
foveatus, Lec.
Androchirus femoralis, Lec.

LAGRIIDÆ.

Arthromacra ænea, Say.
Stitira resplendens, Muls.
gagatina, Mels.

PYROCHROIDÆ.

Pyrochroa flabellata, Fab.
femoralis, Lec.
Dendroides canadensis, Latr.
concolor, Newm.

ANTHICIDÆ.

Eurygenius wildii, Lec.
Stereopalpus mellyi, Laf.
Corphyra lugubrls, Say.
fulvipes, Newm.
labiata, Say.
terminalis, Say.
collaris, Say.
canaliculata, Lec.
impressa, Say.
Macratria murina, Fabr.
Notoxus monodon, Fabr.
bifasciatus, Lec.
bicolor, Say.
Tomoderus interruptus, Laf.
Anthicus obscurus, Laf.
cinctus, Say.
formicarius, Laf.
floralis, Payk.
defficilis, Lec.
cervinus, Laf.
Xlophilus fasciatus, Mels.
basalis, Lec.
nebulosus.

MELANDRYIDÆ.

Canifa plagiata, Mels.
pallipes, Mels.
Tetratoma truncorum, Lec.
Penthe obliquata, Fabr.
pimelia, Fabr.
Synchroa punctata, Newm.
Osphya varians, Lec.
Melandria striata, Say.
Xylita decolorata, Rand.
Spilotus quadripustulosus, Mels.
Mystaxia simulator, Newm.
Euchodes sericea, Hald.
Hypulus liturata, Lec.
concolor, Lec.
Symphora flavicollis, Hald.
rugosa, Hald.
Hallomenus scapularis, Mels.
Eustrophus confinus, Lec.
bicolor, Say.
bifasciatus, Say.
tomentosus, Say.
Orchesia castanea, Mels.

MORDELLIDÆ.

Pentaria trifasciata, Mels.
Tomoxia bidentata, Say.
linella, Lec.
Glipa hilaris, Say.
Mordella scutellaris, Fab.
octopunctata, Fab.
marginata, Mels.
serval, Say.
oculata, Say.
triloba, Say.
discoidea, Mels.
Mordellistena lutea, Mels.
limbalis, Mels.
ornata, Muls.
scapularis, Say.
tosta, Lec.
picicornis, Lec.
fulvicollis, Mels.
varians, Lec.
pustulata, Mels.
fuscipennis, Mels.
ambusta, Lec.
unicolor, Lec.
pubescens, Fabr.
liturata, Mels.
bihamata, Mels.
hebraica, Lec.
fuscata, Mels.
vittigera, Lec.

MELOIDÆ.

Epicauta vittata, Fabr.
lemniscata, Fabr.
cinerea, Forst.
pennsylvanica, DeG.

CEPHALOIDÆ.

Cephaloon lepturides, Newm.

ŒDEMERIDÆ.

Microtonus sericans, Lec.
Asclera thoracica, Fab.
ruficollis, Say.
puncticollis, Say.

PYTHIDÆ.

Pytho americanus, Kirby.

RHYNCHITIDÆ.

Engnamptus augustatus, Hbst.
collaris, Gyll.

OTIORHYNCHIDÆ.

Tanymecus confertus, Schh.

Cercopius chrysorrhæus, Say.
Brachystylus acutus, Say.
Phyxelis glomorosus, Schh.
rigidus, Say.
Chryphomimus dorsalis, Horn.

CURCULIONIDÆ.

Sitones flavescens, Marsh.
Ithycerus noveboracensis, Forst.
Phytonomus comptus, Say.
Listronotus latiusculus, Boh.
tuberosus, Lec.
Lixus concavus, Say.
terminalis, Lec.
sylvius, Boh.
Dorytomus mucidus, Say.
Pachytychius amœnus, Say.
Smicronyx tychioides, Lec.
vestitus, Lec.
corniculatus, Fabr.
ovipennis, Lec.
Lissorhoptrus simplex, Say.
Bagous sellatus, Lec.
Otidocephalus myrmex, Hbst.
chevrolatii, Horn.
Magdalus armicollis, Say.
pallidus, Say.
pandura, Say.
Anthonomus cratægi, Walsh.
4 gibbus, Say.
scutellatus, Gyll.
protundus, Lec.
suturalis, Lec.
nebulosus, Lec.
disjunctus, Lec.
bisignatus, Say.
Orchestes ephippiatus, Say.
pallicornis, Say.
canus, Horn.
niger, Horn.
Piazorhinus scutellaris, Say.
Plocetes ulmi, Lec.
Plocarmus hispidulus, Lec.
Gymnetron teter, Lec.
Conotrachelus affinis, Schh.
anaglypticus, Say.
cratægi, Walsh.
cribicollis, Say.
elegans, Say.
nunuphar, Hbst.
juglandis, Lec.
seniculus, Lec.
erinaceus, Lec.
gemminatus, Lec.
tuberosus, Lec.
posticatus, Say.
Rhyssematus palmacollis, Say.
æqualis, Horn.
Acamptus rigidus, Lec.
Tyloderma foveolatum, Say.
æreum, Say.
fragariæ, Reily.
Cryptorhynchus bisignatus, Say.
ferratus, Say.
minutissimus, Lec.
obtentus, Hbst.
fallax, Lec.
Piazurus oculatus, Say.
Copturus quercus, Say.
Craponius inæqualis, Say.
Alyca ephippiata, Lec.
Cœliodes acephalus, Say.
curtus, Say.
flavicaudis, Boh.
Centhorhynchus rapæ, Gyll.
sulcipenrus.
puberulus, Lec.
Pelonomus sulcicollis, Fabr.
Coelogaster zimmermani, Gyll.
Rhinoncus pyrrhopus, Boh.
longulus, Lec.
pericarpius, Linn.
Aulobaris ibis, Lec.
Baris ærea, Boh.
umbilicata, Lec.
nigrinus, Say.
augustatus, Lec.
trinotatus, Say.
rugicollis, Lec.
Ampeloglypter sesostris, Lec.
Madarus undulala, Boh.
Centrinus penicellus, Hbst.
scutellum album, Say.
rectirostris, Lec.
perscitus, Hbst.
Zygobaris conspersa, Lec.
Barilepton cribicolle, Lec.
Balaninus nasicus, Lec.
Euchætes echidna, Lec.
Phyrdemus undatus, Say.
Microhyus setiger, Lec.
Coccotorus scutellaris, Lec.
Himantium errans, Lec.
And many unnamed species.

BRENTHIDÆ.

Eupsalis minuta, Drury.

CALANDRIDÆ.

Sphenophorus callosus, Oliv.
cariosus, Oliv.
13-punctatus, Ill.
zeæ, Walsh.
Calandra oryzæ, Linn.
granaria, Fabr.

Cossonus concinnus, Boh.
platalea, Say.
Stenoscelis brevis, Boh.

SCOLYTIDÆ.

Platypus compositus, Say.
Monarthrum fasciatum, Say.
mali, Fitch.
Xlotretus politus, Say.
Xleborus xlographus, Say.
pubescens, Zimm.
Scolytus muticus, Say.
silvius, Boh.
Hylesinus opaculus, Say.
Dendrocinus aculeatus, Say.
Cnesinus strigicollis, Lec.

ANTHRIBIDÆ.

Tropideres rectus, Lec.
bimaculata, Oliv.
Eurymycter fasciatus, Oliv.
Hormiscus saltator, Lec.
Eusphyrus walshii, Lec.
Toxotropis pusillus, Lec.
Piezocorynus mixtus, Lec.
dispar, Gyll.
Anthribus cornutus, Say.
Cratoparus lunatus, Fab.
Brachytarsus variegatus, Say.
tomentosus, Say.
alternatus, Say.
Choragus sayii, Lec.
Aræocerus fasciculatus, DeG.
Anthribus cornutus, Say.

In making up the list the following species were omitted:

CARABIDÆ.

Xestonotus lugubris. Dej.
Anisotarsus piceus, Lec.
terminalis, Say.
Evarthrus sigillatus, Say.
Pterostichus mutus, Say.

STAPHYLINIDÆ.

Erchomus brevis.

HETEROCERIDÆ.

Heterocerus cuniculus, Kies.

CHRYSOMELIDÆ.

Oedionychis quercata. Fab.
Blepharida rhois, Forst.

OTIORHYNCHIDÆ.

Aphrastes tæniatus, Say.

CICINDELA cuprascens, Lec.—On a low, sandy flat, on the Kentucky side of the Ohio river, this species occurs; it swarms by thousands. I have not observed it in any other locality. June to September.

OMOPHRON robustum, Horn.—The sloping banks of Mill Creek produce this species. By splashing them with water, the Omophron come out from where they are concealed and go rushing up the banks, and are easily captured. Of 365 specimens taken at this locality, on July 10th, 180 were tessellatum, 147 were robustum and 38 were americanum.

CYCHRUS andrewsii, Harr.—This species was found in a ravine on the edge of a thick woods; they were concealed in a rotton log. By chopping the log to pieces, over 20 specimens were taken out of it. July 24th.

LEPTOTRACHELUS dorsalis, Dej.—In beating some weeds on the Miami bottom, near "Red Bank," hundreds of this species were taken. The color varied from black to pale buff. May 22.

COPTODERA ærata, Dej.—Abundant under the loose bark of dead beech trees. A very active little insect and difficult to capture. June, July and August.

MEGALOPS cælatus, Grav.—This wonderful little insect was taken on small beech logs. Specimens by Mr. Crawford and myself. April 2d to August 19th.

BLECHRUS pusio, Lec.—In the crevices of some old fence rails, many specimens of this species were taken. March.

OXYPORUS major, Grav. and Stygicus, Say.—In fungus. They were cutting burrows through the tender parts. In no instance were any taken on old or decaying fungus. August 19th to September 29th.

RYMBUS ulkei, Cr.—Taken under bark on old beech logs. September to October.

NECROPHILUS subterraneus, Dahl.—This species was taken on decaying fungus; it was quite rare. September 27th.

GRYNOCHARIS 4l-ineata, Mels.—Found under beech bark. July.

AMPHICROSSUS ciliatus, Oliv.; and PALLODES silaceus, Er.—On freshly cut stumps of the sugar maple. These two species congregate in clusters early in March.

LIODES polita, Lec.—From under loose bark, on a beech log, I took 40 of this species—they were in a cluster. October 13th.

MEGALODACNE ulkei, Cr.—In only one locality has this species been observed, on the Kentucky side of the river, and though I have diligently hunted like situations on the Ohio side, I have failed to find a single specimen. July 5th to October 30th.

EUDESMA undulata, Mels.—One specimen taken by Mr. Siewers, from under loose bark of Sycamore. July.

BOTHRIDERES exaratus, Mels.—From under the bark of a dead elm tree was taken about 150 of this species, and though there were many other dead elms in the vicinity, no more specimens were found. July, August.

HISTER gracilis, Lec.—Found under elm bark. August.

CHALCOPHORA campestris, Say.—The dead beech trees in this vicinity are riddled by this species. They have also been taken from sycamore and maple. July to August.

BUPRESTIS rufipes. Oliv.—Beech and sycamore. August.

ANTHAXIA cyanella, Gory.—From the leaves of a small haw bush, 118 specimens were beaten. June 4th.

PODABRUS fayi, Lec.—Not abundant; beaten from wild grape. June 12th.

PHYLLOBÆNUS dislocatus, Say.—Specimens of this species were taken running along the bark of dead beech trees. June 21st.

NOTHODES dubitans, Lec.—Abundant on weeds in river bottom. May 15 to June 6.

CREGYA oculata and mixta.—Beaten from osage orange. July.

EUCRADA humeralis, Mels.—Found running up and down the trunks of dead beech trees. May 20th.

PARANDRA polita, Say.—Several specimens dug out of dead beech trees by Mr. Siewers and myself.

PHYTON pallidum, Say.—Beaten from osage orange; a very active species. June.

DRYOBIUS sexfasciatus, Say.—This species congregates under loose bark, as many as 5 or 6 having been taken from under one piece. July.

NEOCLYTUS nitidus, Horn.—One specimen taken by Mr. Siewers, June 10th.

CYRTINUS pygmæus, Hald.—By beating wild grape vines when in blossom, this beautiful little longicorn was secured. June.

CREPIDODERA scabricula, Cr.—Abundant on ash sprouts. May 11th.

CORPHYRA lugubris, Say; terminalis, Say; collaris, Say; canaliculata, Lec.; and impressa, Say.—Abundant on blossoms of buckeye and white thorn. April 25th to May 15th.

CORPHYRA fulvipes, Newm, and Labiata, Say.—Abundant on weeds in river bottoms. May 22.

HYPOPHLŒUS, n. sp.—Taken from under the bark of dead osage orange limbs. August.

EUCHÆTES echidna, Lec.—Taken on dead beech trees. They were walking along crevices in the bark, into which they were poking their long and slender snouts. When taken hold of they cling to the bark with the greatest tenacity. June 21st.

PLATYPUS compositus, Say.—Taken from under the bark of buckeye logs. July.

PIEZOCORYNUS dispar and mixta.—Abundant on bark of dead beech. June and July.

HORMISCUS saltator Lec.; and EUSPHYRUS walshii, Lec.—Taken from under the bark of dead osage orange limbs.

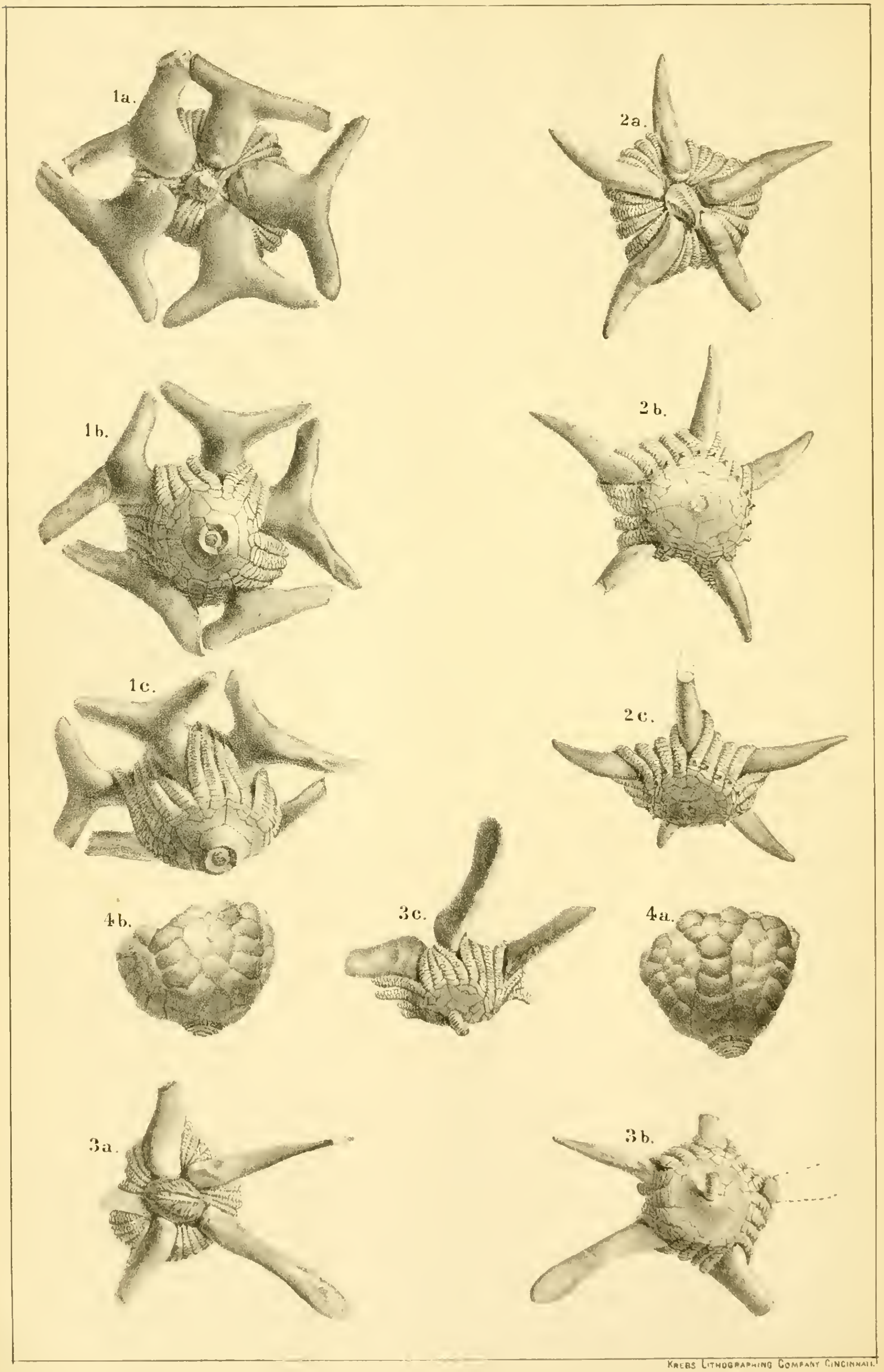

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PLATE XI.

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Pterotocrinus bifurcatus. Natural size. Prof. Wetherby's collection, . 136

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1*b*. Basal view.

1*c*. Side view.

Pterotocrinus acutus. Natural size. Prof. Wetherby's collection, . 134

Fig. 2*a*. Upper view.

2*b*. Basal view.

2*c*. Side view.

Pterotocrinus spatulatus. Natural size. Prof. Wetherby's collection, . 137

Fig. 3*a*. Upper view.

3*b*. Basal view.

3*c*. Side view.

Forbesiocrinus parvus. Two diameters. Prof. Wetherby's collection, . 138

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6*c*. Longitudinal section of the same, enlarged to 5 diameters, and showing the periodically contracted tubes, much as in *Stenopora*.

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Fig. 9. View of an example found at Frankfort, Ky. Natural size. E. O. Ulrich's collection.

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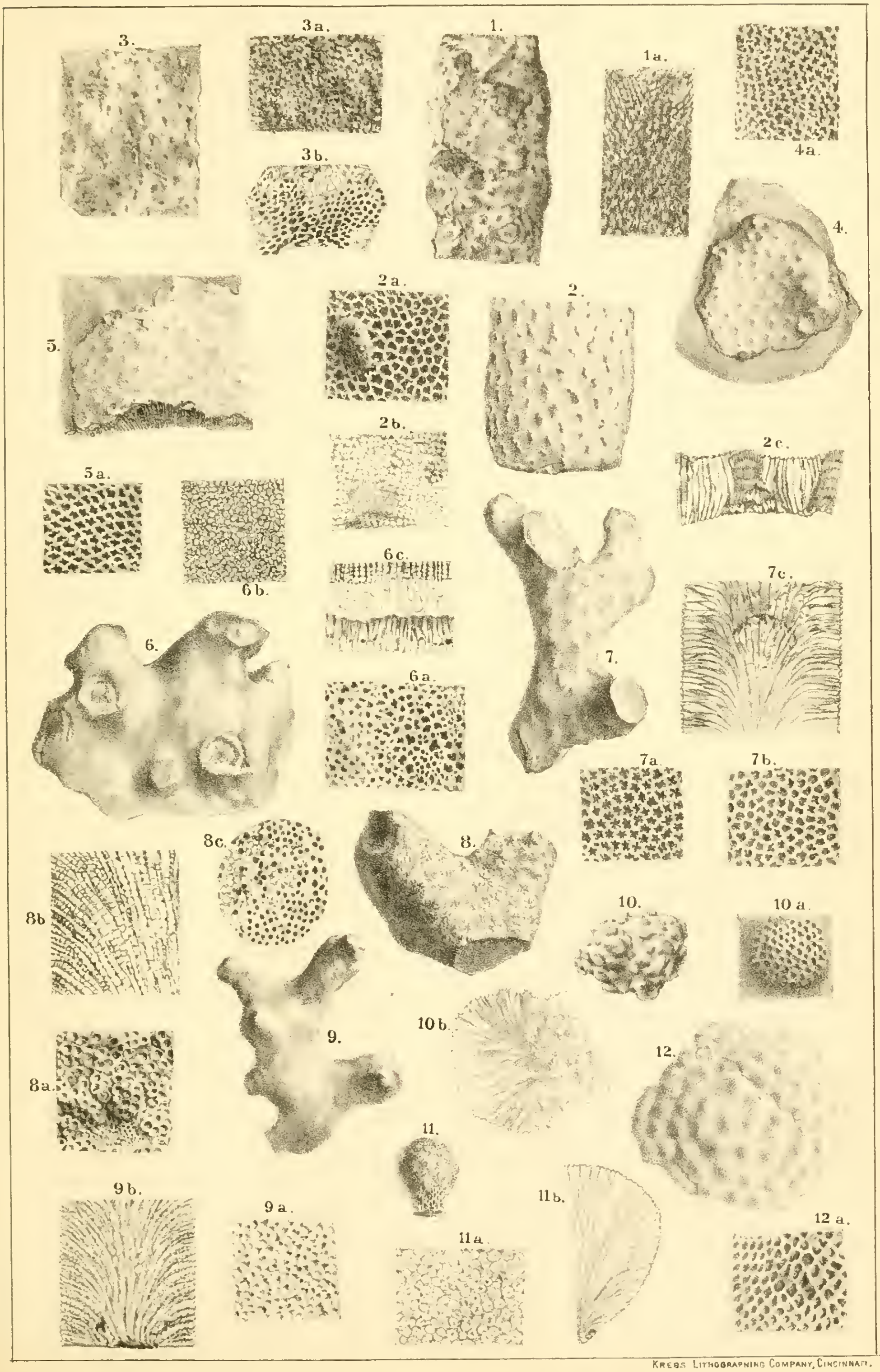
EXPLANATION OF WOODCUTS ON PAGE 14.

Figs. 1 and 2 represent lateral and dorsal views of the best specimen found. In freeing this specimen from its matrix, the frontal prolongation was, unfortunately, separated from the rest of the cephalic shield, and lost. Its position, however, is sufficiently indicated by the fracture. The snout has been observed (in place) on six other, though less perfect individuals, making it an easy matter to restore the same on the specimen figured.

Fig. 3. An outline view of the under side of the movable cheeks and snout, showing the position and course of the frontal suture.



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DESCRIPTIONS OF SOME NEW TINEINA, WITH NOTES ON A FEW OLD SPECIES.

By V. T. Chambers.

In the past two years I have done but little in Entomology, that little having been done mainly in the study of larval history and habits; and the descriptions and notes published during that time having been the result of previous study, so far as they relate to the mature insects. The following notes comprise descriptions of new species which have been received from correspondents during the period mentioned, together with a few notes on species heretofore described. The Texas specimens are from Mr. Belfrages.

Anesychia texanella, n. sp.

Described from two specimens, one of which is much more distinctly marked than the other. To the unaided eye they appear pale, grayish white; under a lens, sparsely dusted with fuscus scales, an oblique fuscus spot or streak on the disc (on forewings) just before the middle, and a more indistinct streak or spot about half way between the one just mentioned and the base of the wing; and another at the end of the cell. Cilia pale stramineous, flecked with fuscus. The fuscus dust-

ing is more distinct on the legs and abdomen, and the anterior surface of the tarsi is distinctly fuscus. Antennæ, yellowish, not at all pectinate or pubescent. Minute maxillary palpi are perceptible, tongue scaled. Though perhaps not a typical *Anesychia*, I see no reason to separate it from that genus. *Al. ex.*, one inch. Texas.

Hyponomeuta texanella, n. sp.

At first glance I supposed this to be *H. longimaculella*, Cham., but closer examination convinces me that it is distinct. Both species differ from our other species of this genus in having many of the spots on the wings oblong.

White: Basal half of the second joint of the palpi, blackish; with no annulations on the third joint. Basal joint of antennæ with a black spot on its tip above; stalk, white at the base, gradually becoming more fuscus towards the tip, the fuscus part marked with a faint, whitish spot on each joint. There are a black spot on the vertex, four on top of the thorax, and one behind each eye; of the four on top, two are on the anterior margin, and one on each side of the apex. Base of costal margin of forewings, black, extending along the extreme costa, and sending a branch within it; a small black spot on the base of the fold; around the apex a row of circular black spots, and fourteen or fifteen others scattered over each wing, those along the costal margin and disc being much more elongate than those in the dorsal part of the wing, three spots lying in a line along the middle being more elongate than the others. Abdomen and legs, yellow, the tarsi marked with fuscus spots on the anterior surfaces of the first two pair. *Al. ex.*, 15-16th inch, Texas. One of the specimens has three of the eggs adhering to the apex of the abdomen. They are very pretty, being elongate ovate, iridescent, and ornamented with longitudinal ridges of beads.

Harpalyce albella, Cham.

I wish to amend the generic diagnosis by adding that the antennæ are stout, and microscopically pubescent, and the tongue naked. I have elsewhere called attention to the fact that the generic name is already preoccupied, and I therefore change it to Ide.

In this species the costal margin is yellow ; and the amount of fuscus dusting on the white forewings varies, though there is never much of it, and occasionally it is aggregated into small spots on the disc, and these are sometimes inclosed in a yellow annulus, and the entire under surface and legs are stained yellowish.

Pluteloptera, gen. nov.

This species belongs to the Plutellidæ. The form of the wings and the neuration resembles that of *Plutella.* I possess but a single specimen in good condition.

Forewings: These differ from those of *Plutella cruciferarum* only by having two branches of the discal vein continued through the cell in which they unite, forming an independent, elongate, triangular cell, beside the secondary cell seen in *Plutella.*

Hindwings: These show no secondary cell, the marginal veins not being continued through the cell. The number of marginal veins is the same as in *P. cruciferarum*, but they differ somewhat from that species in position.

Vertex, roughened; face, smooth, basal antennal joint, with depending hair-like scales; antennæ, slender; tongue, long, naked; no maxilary palpi; labial palpi, porrected long enough to reach the base of the antennæ; second joint, clavate, and joints of about equal length.

Pluteloptera ochrella, n. sp.

Basal joint of antennæ, white, stained with fuscus; stalk, white, each joint having a black dot above, and one on each side. Face and palpi, brown, sprinkled with white scales. Head, thorax, and forewings, yellowish ochreous, with (on the forewings) a small brown spot about the middle of the fold. Hindwings, pale lead color. Abdomen and legs, brown, dusted with white. *Al. ex.*, 5-8th inch. Texas.

GELECHIA.

G. pinifoliella, n. sp.

Palpi, simple; hindwings, excised beneath the tip. Head, white, flecked with scales of the general hue of the insect, which may be called a brownish yellow, though it is difficult to define its exact hue. Palpi, white; the second joint longer than the third, brownish yellow, flecked with fuscus scales on the outer side; third joint, white, with a brownish yellow annulus about its middle, and another near its tip. Antennæ, white, each joint crossed by a brownish band. Thorax and forewings of the general hue above mentioned, flecked with fuscus scales. On the forewings are three white fascia, placed about the basal fourth, middle, and apical fourth of the wing-length; the apex densely dusted with fuscus scales on a white ground; and the dorsal

margin sparsely flecked with brown; the fascia also are more or less margined with brown scales, and the third fascia is sometimes interrupted in the middle; and the fuscus scales, which margin the first and second fascia (especially near the fold along the second fascia), form minute tufts of raised scales. Cilia grayish, with black scales, tipped with white, interspersed among them. Under side of the wing, brownish. Hindwings, pale grayish, with light cilia. Abdomen, brown above, whitish toward the apex beneath. *Al. ex.*, $\frac{3}{8}$th inch.

This description has, at the request of Prof. Comstock, been furnished to him for the forthcoming volume of the Report of the U. S. Agricultural Department. The species was received for identification from Prof. Comstock, who informs me that the larva mines the leaves of a species of pine tree (*Abies* sp.). Prof. C. will no doubt furnish more complete details of its life history.

Mr. Stainton, in a letter, states that a *Gelechia* mining pine leaves is new to him, but that the ornamentation of this species, as briefly described in my letter, suggests a superficial resemblance to *Œcophora angustella*, Hüb. I can not, however, refer this species to *Œcophora* for many reasons. Its proper place is in *Gelechia*, and although the ground color is quite different, yet the fascia and small raised tufts recall the European *G. dodecella*, which is also a pine feeding species.

G. obliquifasciella, n. sp.

Palpi. simple, brown on the outer surface, white within, with a white annulus on the apex of the second joint, one on the base of the third, and another before the top of the third. Head, sordid or grayish white, iridescent. Antennæ, sordid, pale brownish. Thorax and forewings, brown, the dorsal margin of the wings white; an oblique white fascia crosses the wings before the basal fourth, passing into the white of the dorsal margin. Abdomen, brownish, with the annal tuft sordid yellowish. Legs, yellowish, marked with brown on their anterior surfaces. *Al. ex.*, 9-16th inch. Texas.

G. quadrimaculella, Cham.

In the description the ground color is said to be brown; but there is great variation in the depth of the color, some specimens being rather of a dark ashen hue than brown. *G. pravinominella*, Cham., though having the spots nearly as in this species darker. and has a large brush on the second joint of the palpi, whilst this species has the palpi slender. and without a brush. This also has the third palpal joint as long as the second, and of a paler hue.

G. BIMINIMACULELLA, n. sp.

A little larger than *G. pseudacaciella*, Cham., which it greatly resembles, and of which it *may* prove to be a variety. It is a little darker color, and lacks the white dusting in the apical part of the wing, and it has a small ochreous spot on each side of the apex of the thorax, which is wanting in *pseudacaciella.* Otherwise, the species resemble closely being brown, with a faint purplish hue, more or less distinctly streaked longitudinally, with ochreous within the costal margin. Texas.

G. ROSEOSUFFUSELLA, Clem.

Three California specimens, for which I am indebted to Mr. Behrens, and which I refer to this species, have the fascia reddish brown, the white part of the wings a little dusted with brown, and no trace of the roseate tinge.

ANARSIA.

A. (?) BELFRAGESELLA, n. sp.

Perhaps more properly referred to *Gelechia.* I refer it to *Anarsia*, mainly because of the structure of the palpi, which resembles those of *A. lineatella*, Zell.

Pale gray. Outer surface of the second joint of palpi and a ring before the tip of the third joint, brown. Antennæ, with the annulations alternately brown and gray. There are two or three small brownish spots on top of the thorax, a short brown streak from the base of the costa of the forewings, and a small brown spot beneath the fold, near the base, a small tuft of raised brown scales within the dorsal margin, before the middle; a small diffused brownish spot about the middle of the wing, and two small raised tufts at about the apical third of the wing (one just within each margin), with two narrow white streaks passing backwards between them. The dorsal margin behind the tuft is bordered by a narrow white streak, which becomes confluent at the anal angle with a narrow oblique white fascia, which begins on the costal margin opposite to the tuft. There is a white dash near the apex behind the confluence of the white streaks; behind the oblique white fascia is an oblique orange-colored costal streak, and behind this again are two white streaks perpendicular to the costa. Cilia, brown, with a whitish hinder marginal line. Abdomen and legs, gray, blotched with brown spots. *Al. ex.*, 7-16th inch. Texas.

NOTHRIS.

N. BIMACULELLA, Cham.

Originally described from Colorado, since received from Texas.

N. CITRIFOLIELLA, Cham.

It is possible that this species may be already known in Europe, but I have not been able to find any account of it. If known, then it ought to be found in Mr. Stainton's "Tineina of Southern Europe," a work which is probably not to be found in this country—at least it is not found in some of the best libraries, as, *e. g.*, at Washington, Cambridge and Boston. It is important that it should be known in this country, and I therefore describe it as a new species; since, if it is already known, the accounts of it are not accessible in this country. Yet since the larva feeds upon the leaves and leaf buds of the orange, the species can not be indigenous, if the orange is its only food plant, and as yet none other is known; it will, therefore, probably be found in Southern Europe, if it has not been already. I have received it from Prof. Comstock of the U. S. Agricultural Department for identification and description in the forthcoming volume of the report of that department, from which this account is taken. Prof. Comstock informs me that the young larvæ feed on the leaf buds, and the older ones on the leaves which they fold, and within which fold they live and pupate, and that it is committing serious ravages in the orange groves of Florida. But he will no doubt furnish fuller and more adequate information in the Report above referred to.

A letter from Mr. Stainton (received since the foregoing was written) informs me that a *Nothris* feeding on leaf buds of orange, is entirely new to him, but that this species, from my brief notes of it in a letter to him, is quite in the style of *N. Durdhamella*, Sta. I know *Durdhamella* only by the brief description in *Ins. Brit.*, v. 3, and the resemblance of this species to it had already occurred to me; but the statement in Mr. Stainton's description of *Durdhamella*, "beyond the middle is a cloudy, fuscus fascia, and the apex of the hind margin is dark fuscus," does not apply to this species, and there are also other less striking differences. *Durdhamella* "has occured on *Durdham* Downs, near Bristol, and at Teignmouth, in England" *(loc. cit.)*, where it is not likely that it fed on orange leaves, and if this species is the same, it must have other food plants. Abdomen, ochreous, dusted with fuscus. Legs, ochreous, stained with fuscus on their anterior surfaces. *Al. ex.*, 11-16th inch.

The imago is ochreous gray (under a lens, ochreous, dusted with fuscus). Outer surface of the second joint of the palpi, brown, except its anterior margin, which is pale ochreous, the third joint is acicular, longer than the second, and springs from the middle of the anterior margin of the tuft of the second joint; it is pale ochreous, tipped with fuscus. Antennæ, minutely pectinated and microscopically pubescent, ochreous, dotted with fuscus on the upper surface, and with the upper surface of the basal joint fuscus. On the disc of the forewings, at about the basal fourth, is a short, obscure, oblique, reddish fuscus streak, and behind it is a small brown discal spot, with another like it placed opposite to it, touching the fold; further back on the disc, are two similar brown spots; and a little behind them, on the dorsal margin, at the end of the fold, is a much larger spot or patch of the same color. The wing behind the discal nervure, is paler than it is before it, and shows indistinctly a wavy transverse fuscus streak; and there are five circular black spots around the apical margin. Cilia, pale ochreous. Hindwings, pale grayish fuscus, scarcely excised beneath the tip.

Coriscium quinquestrigella, Cham.

Slight differences in the markings of numerous specimens make it *possible* that two species are included under this name, but I think there is only one.

Coleophora bistrigella, Cham.

I have elsewhere suggested that *C. basistrigella*, Cham., *might* be the same species. I am now, however, convinced that they are distinct species.

Coleophora inornatella, Cham.

Palpi and antennæ, simple and shorter than usual in *Coleophora*. Entire insect pale, sordid or leaden, ochreous, except the middle part of the forewings, which is white from the base nearly to the apex. *Al. ex.*, 3-8th inch. Texas.

Laverna sabalella, n. sp.

This species, like two others previously mentioned in this paper, was received from Prof. Comstock, and described by me for the forthcoming volume of the U. S. Agricultural Report, in which further particulars of its life history will be found. Prof. Comstock informs me that the

larva feeds on the under side of the leaves of the Palmetto (*Sabal* sp?) in Florida. It forms of its frass, or excrement, large tubes or galleries under which it lives. The frass forms masses of considerable size. I have but a single specimen, and that is slightly worn. The palpi are rather long, slender and acuminate, somewhat like those of *L. gleditschiæella*, Cham., and the wings are elongate and narrower than in *gleditschiæella.*

Very pale ochreous yellow, or perhaps rather stramineous; outer surface of the second joint of the palpi, brown. There is a small brown spot on the fold near the hind margin of the forewings, and a larger one at the end of the disc nearer to the dorsal than the costal margin. *Al. ex.*, 5-8th of an inch.

Œnoe hybromella, Cham.

This species is very difficult as to its location. The neuration of the wings places it among the *Elachistidæ*, whilst its trophi seem to ally it to *Tinea.* Its ornamentation is so similar to that of *Tinea tapetzella* that it looks like a pigmy *tapetzella.*

Æaea quadricustatella, n. sp.

Nearer to *A. ostryæella*, Cham., than to *A. purpuriella*, Cham. The three species differ slightly in the neuration of the wings; indeed, in this species, that of the hindwings (except the median, which is furcate on the hind margin), is almost obsolete, and this species also has the palpi a little longer and more slender than the others. A character of all three is the prominent, obtusely pointed forehead. This species is darker gray than *ostryæella*, not so brown as *purpuriella*, and the size is that of *ostryæella*, and smaller than *purpuriella.* There are four small raised tufts on each forewing, placed like those of *purpuriella.* Anterior surface of legs, dark brownish gray. Texas.

Ætia, gen. nov.

Forewings, lanceolate; hindwings, linear. In the forewings the costal vein attains the margin before the middle; the subcostal subdivides into four branches, the first of which is before the middle, the other three nearer together, and the last one attaining the margin just before the apex. Cell, unclosed? (or closed by a very indistinct discal vein); an independent discal branch goes to the apex. In the apical part of the wing the median subdivides into the equidistant branches; submedian distinct, simple. In the hindwings the cell is unclosed;

the costal is short and indistinct; subcostal without branches goes straight to the margin in the apical part of the wing. Median (or submedian?) distinct, attaining the hind margin about midway its length; an indistinct fold (the median vein?) along the middle of the wing.

Head, smooth; vertex, arched; face, full, but less so than in the genus *Aeaea.* Antennæ, slender, subpectinate toward the apex, more than half as long as the wings; tongue, long, naked; no maxillary palpi; labial palpi, drooping (probably recurved in the living insect); divergents, slender, joints of about equal size; ocelli, none; eyes, moderate.

A. BIPUNCTELLA, n. sp.

Yellowish ochreous, with a small blackish spot on the fold before the middle; another behind the middle beneath the fold, with one nearly opposite to it on the disc, and another at the end of the cell. *Al. ex.*, 3-8th inch. Texas.

ELACHISTA BICRISTATELLA, n. sp.

Next to the *Gelechidæ*, the *Elachistidæ* appear to be most numerous, both in species and individuals among the Texan Tineina, judging from the collections that I have received from that region. Many of the species, however, can not be placed in *Elachista*, though closely allied to it (such as *Eriphia*, *Aeaea*, etc.), whilst some that I have referred to, *Elachista*, will, perhaps, be removed from it. Dr. Clemens describes as *E? orichalcella*, a species which Mr. Stainton "imagines to be quite distinct from" *Elachista*. Unfortunately it was described very briefly from a single specimen which does not seem to be now extant. From Dr. Clemens' description, I supposed it might possibly be *Eriphia concolorella*, Cham., but Dr. Clemens' account of the neuration does not agree with that of *Eriphia*, and *orichalcella* is described as of a metallic cupreous color, and *Eriphia concolorella* is of a dark bronzy brown. Some of the species which approach *Elachista* closely, have raised tufts on their wings, and this (*bicristatella*) is one of them.

Palpi, simple, slender, drooping; antennæ, slender, more than half as long as the forewings. Insect, dark grayish brown. About the middle of the costal margin of the forewings is a small white spot, which almost touches an opposite larger dorsal white spot, which is margined behind by a tuft of raised scales; and just before the cilia is

a similar pair of white spots, the dorsal one being likewise margined behind by a raised tuft. There are also some white scales in the dorsal cilia. Posterior tarsi, annulate with white. *Al. ex.*, ½ inch. Texas.

Eulyonetia, gen. nov.

I am greatly puzzled as to the proper location of the insect which I make the type of this genus. There is nothing in the general appearance of the insect which suggests any close resemblance to *Lyonetia;* it rather, in fact, seems to belong to the *Elachistidæ*. The neuration, however, allies it to *Lyonetia*. Forewings, linear lanceolate; submedian, furcate at base; costal attaining the margin about the middle; cell, long and narrow; the subcostal subdivides into four branches, the first arising before the middle, and the last going to the apex, with a branch to the dorsal margin, and the first farther removed from the others than they are from each other; discal vein, oblique, with a branch to the dorsal margin; median, unbranched, attaining the margin behind the end of the cell. Hindwings, linear; cell, unclosed; costal vein, very long; median, furcate; fold, indicated; submedian, very distinct.

In the single specimen before me the vertex is denuded; face, smooth; palpi like those of some species of *Elachista*, the third joint shorter than the second, slightly drooping in the dead insect. No maxillary palpi; tongue of moderate length, scaled. Face slightly retreating (less so than in *Lithocolletis*). Ocelli, none. Basal joint of antennæ, somewhat enlarged, but not forming an eye cap; stalk, shorter and more robust than in *Lithocolletis*.

On the whole, I incline to refer the insect to the family *Elachistidæ* of Stainton; but, in the absence of all knowledge of the larvæ, it is frequently difficult to determine the affinities of these little creatures.

Eulyonetia inornatella, n. sp.

White, tinged with pale straw yellow, with the dorsal and apical parts of the wings distinctly straw yellow. Antennæ, white, annulate with stramineous. *Al. ex.*, about one third inch. Texas.

DRYOPE.

The neuration of the forewings in this *genus* is almost exactly that of *Blastobasis*, Zell, whilst that of the hindwings allies it to the *Elachistidæ*.

Lithocolletis sexnotella, n. sp.

Belongs to the same group with *argentinotella*, *rileyella*, *fitchella*, *quescitorum*, etc., but has no basal streak, and has only four costal and two dorsal streaks on the forewings. The head, antennæ and palpi, are silvery white; thorax and forewings, pale saffron yellow; the costal and dorsal streaks are distinctly dark margined before; the first costal streak is about the middle of the wing-length, narrow and oblique, and is placed opposite to the large curved first dorsal streak; the second costal streak is behind the middle, and behind it are two others about equidistant. The second dorsal is rather large and triangular, and placed opposite to the space between the second and third costal streaks. Apical spot small, brownish, and rather obscure; and the hinder marginal line at base of the cilia is not very distinct; a little smaller, perhaps, than *fitchella*, and the plainest species of its group.

Lithocolletis quinquenotella, n. sp.

Face, palpi and antennæ, silvery white, the antennæ faintly stained with fuscus. Vertex, thorax and forewings, yellowish saffron (less golden than *argentinotella*, Clem.) Forewings with four silvery costal streaks, the first two oblique, and the others perpendicular to the margin, and the last passing into the white ground color of the apex, which is densely dusted with fuscus ; none of the costal streaks are dark margined. Opposite to the apex of the first costal streak begins a long, oblique dorsal streak, which, behind the middle of the wing-length, becomes confluent with the second costal streak, and is strongly dark margined behind. There is no basal streak, apical spot, or hinder marginal line. Legs, silvery white; but the first pair of tarsi are marked on their anterior surfaces with fuscus spots. Abdomen silvery white, stained with pale lead color beneath. *Al. ex.*, a little over one fourth inch. Texas.

Lithocolletis desmodiella, Clem.

I have received from Miss Mary E. Muntfeldt a specimen which I refer to this species, and which she informs me was bred from larvæ mining leaves of the kidney bean (*Phaseolus*). Heretofore it has been bred only from the leaves of *Desmodium*, in which the mine is very small, and from which each mine has only given a single specimen; whereas, Miss Muntfeldt describes the mine as a large bladder-like mine in *Phaseolus*, and says that several specimens came from a single mine. The single specimen from *Phaseolus* that I have seen was less

brilliant than those bred from *Desmodium*, and has the dark margins of the fascia less distinct. Otherwise, I have not noted any difference.

Lithocolletis celtisella, Cham., and L. tritæniaella, Cham.

I have heretofore referred the larvæ of these species to the "flat group," having been misled by somewhat hasty observations on the mines found on the upper surfaces of the leaves. In fact, both belong to the "cylindrical group," the larvæ of which are flattened in their first three stages, and cylindrical in the last four. The mine of *tritæniaella* is confined to the upper surfaces of the leaves of its food-plant (*Ostrya*), and is large, roomy and white. The mine of *celtisella* begins on the under surface of the leaves of the hackberry (*Celtis*), where it is long, linear and crooked; but afterwards the larva eats through the parenchyma to the upper cuticle of the leaf, where it makes a flat, blotch-like mine, which is then made tentiform by a small fold of the cuticle. The larva of *L. tritæniaella* is deeply stained with fuscus—in fact, is almost black, being the only larva of the cylindrical group known to me which shows that color.

Lithocolletis solidaginisella, n. sp.

From Mr. W. H. Patton I have received a single specimen of a species bred by him, in Connecticut, from a larva mining a leaf of *Solidago patula*. He was not able to inform me which group the larva belonged to, nor which surface of the leaf was mined by it. The species is not at all closely allied to any of our species heretofore described, and no *Solidago* feeding species of this genus has heretofore been described. *L. basistrigella*, Clem., is, perhaps, its nearest American compeer, and is of about the same size. *Solidaginisella*, however, has but a single basal streak on the forewing, and that one is placed beneath the fold, and extends only to about the basal fourth of the wing length. Vertical tuft, thorax, and upper surface of the forewings pale golden yellow. On the forewings are four silvery white costal and two dorsal streaks. The first two costal streaks are oblique, pointing backward, while the last two point obliquely forward; and all four are rather short, and all are dark margined behind, except the first, which is unmargined; the second and third would, if projected, meet so as to form an obtuse angle about the middle of the wing, where also they would meet the first dorsal streak. The first costal streak is placed a little behind the basal fourth of the wing-length. The two dorsal streaks are longer than the costal ones, and point obliquely back, so that the

apex of the first is between the second and third costal, and the apex of the second is between the third and fourth costal streaks. Cilia of the forewings of the general hue. Hindwings, pale silvery, with a yellowish tinge, and cilia deeper yellowish. Face, palpi and antennæ, white, the antennæ stained above with yellowish, and with a fuscus spot on each joint. Thorax, white; legs, white, with the anterior surface of the second pair, brownish; and the tarsal joints, annulate with brown.

PHYLLOCNISTIS AMPELOPSIELLA, Cham.

I have never bred this species, except from mines in leaves of the Virginia creeper, and, as I have already stated elsewhere, from the same sort of mines in the leaves of that plant I have bred a form indistinguishable from *P. vitifoliella*, Cham., which I have usually obtained from a very different mine in grape leaves. *P. ampelopsiella (vera.)*, makes a whitish mine on the *under* side of *Ampelopsis* leaves. The mine, though what we call a linear one, is rather wide. It begins on the side of a vein near the margin, passes down the vein to the midrib, up the midrib to the next vein, up that vein to the margin, where it crosses the vein, passes down it again to the midrib, and so on until some times more than half of a leaf will be ruined. The track is whitish, with a narrow central black line of frass. In a single instance, I found a similar mine on the upper side of the leaf containing a dead larva. I have seen thousands of these mines on the under side of the leaf, all such as I have just described, and from them I have bred indiscriminately the true *P. ampelopsiella*, and *P. vitifoliella*. The differences between them are palpable. *Ampelopsiella* is a little larger and more coarsely scaled than *vitifoliella*, and has a dark fuscus streak extending from the base to the middle of the wing, and a dark fuscus spot on dorsal margin before the middle. This streak and spot are always absent in *vitifoliella*, which has also a more silvery lustre. *Vitifoliella* mines the *upper* surface of grape leaves, eats more deeply into the parenchyma, and the track or mine is narrower, and not white like that of *ampelopsiella* : it is long and irregular, wandering all over the leaf without regard to the venation. I have never seen or heard of it on the *under* side of the leaf. These differences are constant and palpable. Do they mark species or varieties ? I consider them distinct species, but I have received, both from Miss Muntfeldt and Prof. Comstock, specimens of the true *ampelopsiella*, from which they inform me were bred from grape leaves; but I do not know the character of the

mines, nor the surface of the leaves, from which they were bred. If *vitifoliella* and *ampelopsiella* are forms of the same species, what shall we say of *P. vitigenella*, Clem.? Its mine is always on the *upper* surface of grape leaves, and it has never been met with in those of *ampelopsis*. It is very different from the mine of *ampelopsiella*, more like that of *vitifoliella*, inasmuch as it wanders over the leaf regardless of the venation. But the character of the mine is very different from those both of *ampelopsiella* and *vitifoliella*, inasmuch as it is barely perceptible, like the track of a minute snail; that is, it looks like an indistinct line of slime, and not like a mine at all. The reason is that the larva hardly burrows through the cuticle, and does not go down into the parenchyma, and the track has a greenish, slimy look. The imago of *vitigenella* is like that of *vitifoliella* in size and lustre, but it has the basal streak and dorsal spot like *ampelopsiella*, only that they are not so *heavy*, not being either so dark or so large as in that species. These differences do not grade into each other; they are always distinct and well marked. I have never seen a specimen (and I have seen hundreds, if not thousands) which could not at once be referred, without hesitation, to its appropriate form, or which showed the slightest indication of any other form than its own, and I should not have the slightest hesitation in considering them clearly distinct species, but for the facts above stated that I get from the *ampelopsiella* mines the *vitifoliella* form as frequently as I do the true *ampelopsiella*, and that Miss Muntfeldt and Prof. Comstock inform me that they have bred the true *ampelopsiella* from grape leaves. Still it is always the true *ampelopsiella*—the true *vitifolella*, or the true *vitigenella*—never any thing between them. It would not be any thing strange if a single species should feed on two plants as closely related as *ampelopsis* and *vitis*. But that the same mine in *ampelopsis* should give two distinct forms; that one of these forms should always come from a different mine in grape leaves, and that a still different form of mine from the same grape leaves should give *always* an intermediate form, and yet that these three forms should always be distinct, with no observed tendency to variation in either, is singular; and one's curiosity is still more piqued when he finds that a mine more like that of *vitigenella* than either of the others; in a plant as far removed, botanically, as the sweet gum (*Liqudamber styraciflora*) should always give a form indistinguishable from *vitifoliella*. The *vitigenella* mine has not been known to produce any thing but *vitigenella*, which is the intermediate form above alluded to.

NEPTICULA.

N. unifasciella, Cham.

Described from specimens bred in Kentucky. I have also received it from Texas.

N. grandisella, n. sp.

Chiefly remarkable for its large size for this genus, having an *al. ex.*, of over 3-8th inch. Face, sordid, straw or sandy yellow, with palpi a little paler; eye-caps, white; antennæ, reddish brown. Body, wings and legs, brown. Texas.

N. maculosella, n. sp.

Resembles *N. nigriruticella*, Cham., and may prove to be the same, or a variety, but I think it is distinct. Antennæ, pale yellowish, stained above with fuscus; eye-caps and palpi, sordid white; vertex, blackish brown; tuft, small; forewings, pale ocherous or yellowish white, dusted with small fuscus spots, with a dark brown longitudinal streak on the costal margin at the base, and near the base a dorsal dark brown spot which reaches the fold, and in the apical part of the wing a very large brown spot or fascia which is widest on the costal margin; cilia, paler than the wings; hindwings, pale lead color; abdomen, pale ochreous beneath, brown above. *Al. ex.*, 1-4 inch. Texas.

N. quercicastanella, Cham., and N. castaneæfoliella, Cham.

I have bred these species from the white oak, as well as the chestnut oak and chestnut.

TINEA.

T. tapetzella, Linn. *var.* occidentella, var. nov.

T. tapetzella is known in this country only by two specimens, one received by Dr. Clemens from Virginia, and one received by me from Quebec. The minute differences of these specimens and European ones, indicated by the notes of Dr. Clemens and myself, are probably not greater than may be observed among European specimens. I have to thank Mr. James Behrens, of San Francisco, for these specimens, sent to me from that place, which I think belong to a variety of *tapetzella*, but which may prove to be a distinct species. In these three

specimens, which agree accurately with each other, the brown basal portion of the wing does not end abruptly as in *tapetzella*, but passes gradually into the whitish portion, which itself is strongly suffused with fuscus. The brown basal portion is posteriorly margined on the fold, by a small brown spot, margined behind by a larger white one. The apex and apical part of the wing are as dark brown as the base, and there are three or four white spots along the base of the dorsal cilia.

Corrigenda.—In my "Address," on pages 73 and 75, the name of Mr. W. H. Edwards is incorrectly given as "H. W. Edwards" and "H. S. Edwards". I regret these errors, and am at a loss to account for them, for not only is the name of Mr. Edwards familiar to me as to all entomologists, but when I wrote the "Address," his papers with his name as author, properly given, lay open before me. V. T. C.

ILLUSTRATIONS OF THE NEURATION OF THE WINGS OF AMERICAN TINEINA.

By V. T. Chambers.

The student of the American Tineina will of necessity be compelled to consult Mr. Stainton's volume of the *Insecta Britannica*, vol. 3, which contains figures of the neuration of the wings of the greater number of genera of European Tineina. The greater number of the Tineina found thus far in America belong to genera already known in England, and illustrated in the volume referred to ; and I have therefore not thought it necessary to give illustrations of the neuration of species belonging to such genera. Dr. Brackenridge Clemens found it necessary to define many new genera among the American species of this group examined by him ; and he has given, in his published papers, illustrations of the neuration of the wings of many species of genera so defined by him ; and I have not thought it necessary to repeat his illustrations here, since the papers of Dr. Clemens, republished by Mr. Stainton, under the title, *Tineina of North America*, will be found to be even more necessary to the student than the volume of *Insecta Britannica* above referred to. Some of Dr. Clemens' genera, however (such as *Parcetopa*), I have found to be identical with genera previously established (*Parcetopa* is equivalent to *Gracillaria*, at least

in part), and in such cases, when Dr. Clemens has not given figures of the neuration, I have given them in the following "Illustrations" for the purpose of establishing the identity of the genera.

I have also met with many new generic types, illustrations of the neuration of which are here first given. In some cases I have given illustrations of the neuration of more than one species belonging to a genus, even when illustrations of that of other species of the same genus have already been given by Mr. Stainton or Dr. Clemens, for the purpose of showing the differences in the neuration of species at present referred to the same genus.

Entomologists differ as to the value of the neuration of insects for the purpose of classification. The value differs no doubt in different orders, or even in families of the same order. In the *Tineina* I have derived more aid from it than from any other single character, though of course the *tout ensemble* of a species must be considered in rightly determining its systematic location, and it is frequently necessary, or at least best, to know its entire history. Among the *Tineina* it sometimes happens that two allied species of a genus have the same neuration, though usually slight differences may be observed even between closely allied species; and minute differences (such as the point at which a vein bifurcates) may be detected even between different specimens of the same species. The neuration is, however, chiefly valuable in determining generic and family relationship of species. No species of the family *Exapatidæ*, Sta., has yet been observed in this country. Among *Tineidæ* there are several species that I can not refer to any of the European genera that are known to me. The neuration of *Hyponomeutidæ* is sufficiently illustrated in *Ins. Brit.*, v. 3. *Pluteloptera* is our only new genus of *Plutellidæ.* It was to be expected that in so comprehensive a family as the *Gelechidæ*, many new generic forms would be found in this country. Some that I have made the types of new genera, as *e. g.*, *Cirrha platanella*, *Œseis bianulella*, *Eido albapalpella* and *Glauce pectenalæella*, will by many no doubt be referred to *Gelechia*, a confused assemblage of species which can hardly be considered a genus. I give no figure of the neuration of any species of *Argyresthidæ*, because we have no new genus belonging to that family. Of the family *Gracilariidæ*, I give illustrations of four species of *Gracilaria*, not because they differ essentially from any of the species of that genus already known, but simply to show what differences obtain in the neuration of the several species, and to establish the fact that I have elsewhere asserted that *Parectopa* of Clemens is *Gracilaria*, in part. No new genera of *Coleophoridæ* have been discovered in this

country, and the neuration is sufficiently illustrated in Mr. Stainton's volume before referred to. It is among *Elachistidæ* that the greatest number of new generic forms, or at least the greatest differences between closely allied forms appears in this country. In this family I am by no means sure that *Perimede erransella*, and *P.* (*Ithome*) *unomaculella* should be referred to the same genus; and while both are allied closely to *Laverna*, I think there are differences sufficient to separate them from that genus; at least these differences would be sufficient if *Laverna* was itself a more homogeneous and better defined group. Perhaps, also, if this were the case, *L. gleditschiæella*, and *L. magnatella* would not be included in *Laverna*, while at present it may be that *Leucophyne tricristatella*, and *Neæra albella* ought not to be separated from it. *Eurynome albella*, which I have included in *Elachistidæ* because of its neuration, betrays in some other respects a closer relation to *Phillonome* and *Bucculatrix*; and *Laverna magnatella* (*L. œnotheriæella*, Cham.) which, I doubt not, is *Phyllocnistis magnatella*, Zell), also in its external characters betrays (especially in its ornamentation) a resemblance to *Phyllocnistis* and *Lyonetiæ*. Thus both through *L. magnatella* and *E. albella* a connection is indicated between the *Elachistidæ* and *Lyonetidæ*. *Œnoe hybromella* is a puzzling species, with the wings of the *Elachistidæ*, it has the head and mouth parts of a *Tinea* nearly, and the ornamentation of *Tinea tapetzella*.

I have given the neuration of four species of *Elachista* as illustrating the variation in this respect in species which I have included in this genus. *Dryope murtfeldtella*, I include in *Elachistidæ*, with very great doubt as to the propriety of so doing. The neuration of the hindwings, as well as their form, and the trophi, exclude it from *Gelechidæ*, whilst the neuration of the forewings is almost exactly that of *Blastobasis*. *Theisoa bifasciella*, Cham., is, I can hardly doubt, the *Œcophora constrictella* of Zeller; yet the neuration shows that it can not be referred to *Œcophora*, or to any other genus of the *Gelechidæ*. I have given no illustration of the neuration of the *Lithocolletidæ*, because it contains as yet but two genera. *Lithocolletis* and *Leucanthiza*, and these are already illustrated in *Ins. Brit.*, vol. 3, and in the writings of Dr. Clemens (*Tin. Nor. Amer.*) *Leucanthiza*, both in the neuration and in the characters of the head and appendages, shows a relation to *Phyllocnistis*, but through *Lithocolletis ornatella* is more closely related to *Lithocolletis*. *Leucanthiza* indicates a connection between the *Lithocolletidæ* and *Lyonetidæ*. In this latter family, *Acanthocnemis*

and *Phyllocnistis* are very near each other, notwithstanding the differences in the neuration and palpi, and *Phillonome* is related to *Bucculatrix*. *Eulyonetia* I place doubtfully in this family, principally because of its neuration, since in many respects it seems to be rather related to the *Elachistidæ*. The neuration of the *Nepticulidæ* is sufficiently illustrated in *Ins. Brit.*, vol. 3.

It will be seen that I have followed the classification of Mr. Stainton; yet the remarks above made seem to me to point toward a closer connection between the *Elachistidæ*, *Lithocolletidæ* and *Lyonetidæ* than appears in Mr. Stainton's system; and I also think *Gracilaria* is separated too widely from *Lithocolletis*, by placing the *Coleophoridæ* and *Elachistidæ* between them; and, as I have elsewhere intimated, there are some facts in the larval history of *Nepticula*, which *seem* to suggest for it a place even above *Gracilaria*.* So if *Œnoe hybromella* belongs in *Elachistidæ*, as it certainly does, if we rely on pterogostic characters alone, it points to a connection with the *Tineidæ*; whilst if *Dryope murtfeldtella* belongs to *Elachistidæ*, it shows almost equal affinities with the *Gelechidæ*. It is too early yet, however, to form a perfect system; but Mr. Stainton has unquestionably the best arrangement of the *Tineina* thus far offered. Many of the species above mentioned are known only as perfect insects, and their location must remain merely provisional until their entire larval and pupal history is known.

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* PSYCHE, Nov. & Dec., 1879.—The reason there given is that the larvæ of *Nepticula* leave the egg with more perfect trophi than those of *Gracilaria*, *Lithocolletis*, *Leucanthiza* and *Phyllocnistis*. The former leave it with trophi of the ordinary Lepidopterous larval type (like fig. 3, *ante* p. 92); the latter with trophi as in fig 1, *loc. cit.*; and they are the only Lepidopterous larvæ that are known to possess such trophi. Larvæ with trophi of this type *must* feed internally; those with trophi as in fig. 3 may be miners or burrowers, as many of them are, though most of them feed externally. The four genera above named also assume trophi of the fig 3 form towards the latter part of their larval existence, while still remaining in the mine, and subject to the same conditions, but some of them leave the mine afterwards, their structure having first been adapted to the subsequent functions. The fig. 1 form is always associated with membraneous thoracic larval legs, and at the moult at which the trophi are changed, as just stated, these legs also are shed, and followed by legs of the ordinary Lepidopterous larval form in *Gracilaria*, *Leucanthiza*, and some *Lithocolletis*; but *Nepticula*, with the fig. 3 trophi, always has membraneous legs, and so has *Phyllocnistis* and a few *Lithocolletis*. It is uncertain whether trophi of the fig. 1 form, and membraneous legs, indicates an earlier stage of development, or are merely degraded or adaptive forms: at any rate their possession by the four genera (not including *Nepticula*) indicates a closer relationship between them than is usually supposed to exist, and if it indicates an earlier stage, then, perhaps, *Nepticula* should precede them, notwithstanding that it also has membraneous legs. If as Sir John Lubback supposes, *Campodea*, or some similar type, represents the original insect form, then these four genera must be degraded as to their trophi and legs, and *Nepticula* also as to its legs But if the original insect type was vermiform, then fig. 1 may represent an earlier stage than fig. 3. As stated above, *Nepticula* also has membraneous legs, but neither they nor those of *Phyllocnistis* are homologous with ordinary Lepidopterous larval legs, they differ in number and situation, and those of *Phyllocnistis* are merely retractile processes. It is difficult to understand how by "natural selection," or adaptation, organs of the *Campodea* type can have given place to organs like those of *Gracilaria*, *Leucanthiza* and *Lithocolletis* temporarily, to reappear in a later stage under the same conditions of existence; or how in *Nepticula* and *Phyllocnistis* they disappear entirely to be followed by locomotive organs of a different kind and number, and differently situated, and then reappear again in the pupa, all under the same conditions of existence.

Besides the references to *Ins. Brit.*, and *Tin. Nor. Amer.*, above given, it is proper to refer to Mr. Riley's figure of the neuration of *Pronuba yuccasella* in vol. 5, "Reports on the Noxious, Beneficial and Other Insects of Missouri." This species, I think, unquestionably belongs to the *Hyponomeutidæ*.

I have not attempted to preserve the relative sizes of the wings, and as I am but a poor draftsman, some slight inaccuracies have been produced no doubt by copying camera drawings, and in reducing some of the figures. Still it is believed the figures will be found sufficiently accurate as to the general form of the wings, and as to the number and position of the nervures.

TINEIDÆ.

1. *Anaphora agrotipennella*, Grote.
2. *Xylesthia clemensella*, Cham.
3. *Cyane visaliella*, Cham.
4. *Amadrya clemensella*, Cham.
5. *Semele cristatella*, Cham.
6. *Pitys fuscocristatella*, Cham.

PLUTELLIDÆ.

7. *Plutelloptera ochrella*, Cham.

GELECHIDÆ.

8. *Hyale coryliella*, Cham. (Perhaps not a *Tineid*).
9. *Ide* (*Harpalyce*) *albella*, Cham.
10. *Cryptolechia* (*Hagno*) *faginella*, Cham.
11. *Gelechia* (*Cirrha*) *platanella*, Cham.
12. *Strobisia iridipennella*, Clem.
13. *Epicorthylis inversella*, Zell.
14. *Sagaritis gracilella*, Cham.
15. *Œseis bianulella*, Cham.
16. *Ypsolophus? querciella*, Cham. (Perhaps rather a *Depressaria*).
17. *Nothris* (*Ypsolophus*) *eupatoriiella*, Cham.
18. *Eido albapalpella*, Cham.
19. *Blepharocera haydenella*, Cham., hindwing (*Blepharocera* is pre-occupied).
20. *Neda plutella*, Cham.
21. *Aganippe biscolorella*, Cham.
22. *Glauce* (*Gelechia*) *pectenalæella*, Cham.
23. *Œcophora* (*Callima*) *argenticinctella*, Clem.
24. *Blastobasis glandulella*, Riley.
25. *Euclemensia bassettella*, Clem.
26. *Polyhymno luteostrigella*, Cham.

Gliphipterygidæ.

27. *Argiope dorsimaculella*, Cham.
28. *Phigalia albella*, Cham. (This *may* belong in *Elachistidæ.*)
29. *Litharïapteryx abroniæella*, Cham.
30. *Heliozella æsella*, Cham., hindwing.

Gracilariæ.

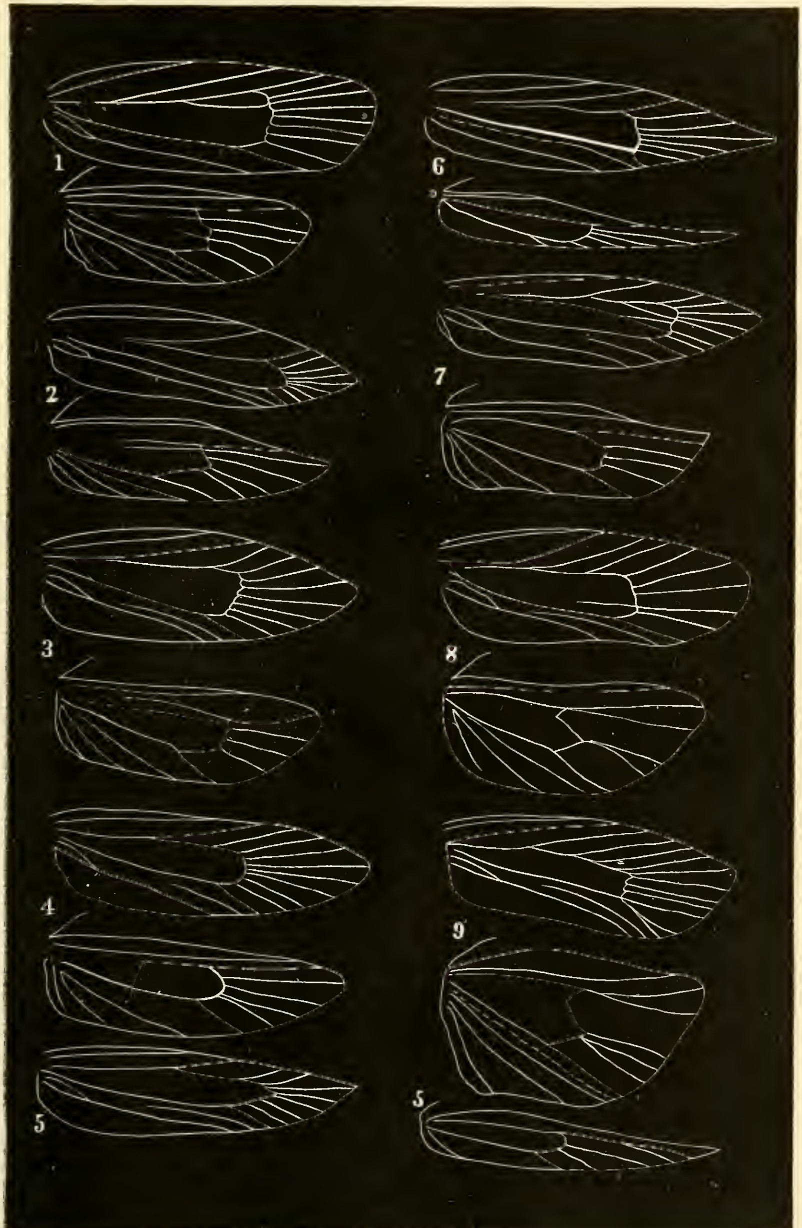
31. *Gracilaria sauzilotiella*, Cham.
32. " *salicifoliella*, Cham.
33. " *(Parectopa) robiniella*, Clem.
34. " *(Æsyle) fasciella*, Cham.

Elachistidæ.

35. *Perimide (Laverna) erransella*, Cham.
36. " " *unomaculella*, Cham.
37. *Laverna gleditschiæella*, Cham.
38. " *magnatella*, Zell.
39. " *(Leucophryne) tricristatella*, Cham.
40. *Neaera albella*, Cham.
41. *Eriphia concolorella*, Cham.
42. " *nigrilineella*, Cham.
43. *Aeaea purpuriella*, Cham.
44. " *ostryæella*, Cham.
45. *Eurynome albella*, Cham.
46. *Œnoe hybromella*, Cham.
47. *Cosmopteryx 4-lineella*, Cham.
48. *Elachista concolorella*, Cham.
49. " *staintonella*, Cham.
50. " *prematurella*, Clem., forewing.
51. " *texanella*, Cham., hindwing.
52. *Dryope martfeldtella*, Cham.
53. *Theisoa bifasciella*, Cham. (*? Œcophora canstrictella*, Zell.)
54. *Aetole bella*, Cham.
55. *Aetia bipunctella*, Cham.

Lyonetidæ.

56. *Eulyonetia inornatella*, Cham. (Possibly belongs in *Elachistidæ.*)
57. *Phillonome clemensella*, Cham.
58. *Acanthocnemis fuscoscapulella*, Cham.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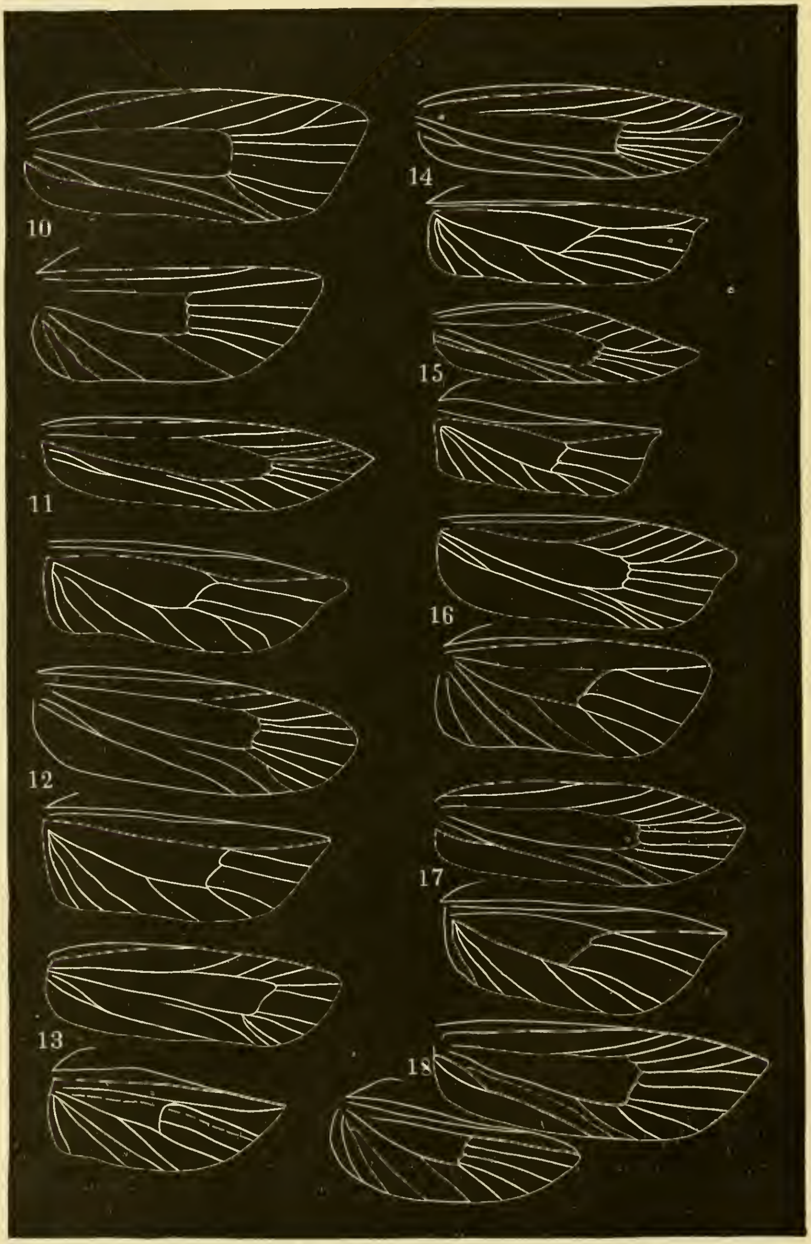
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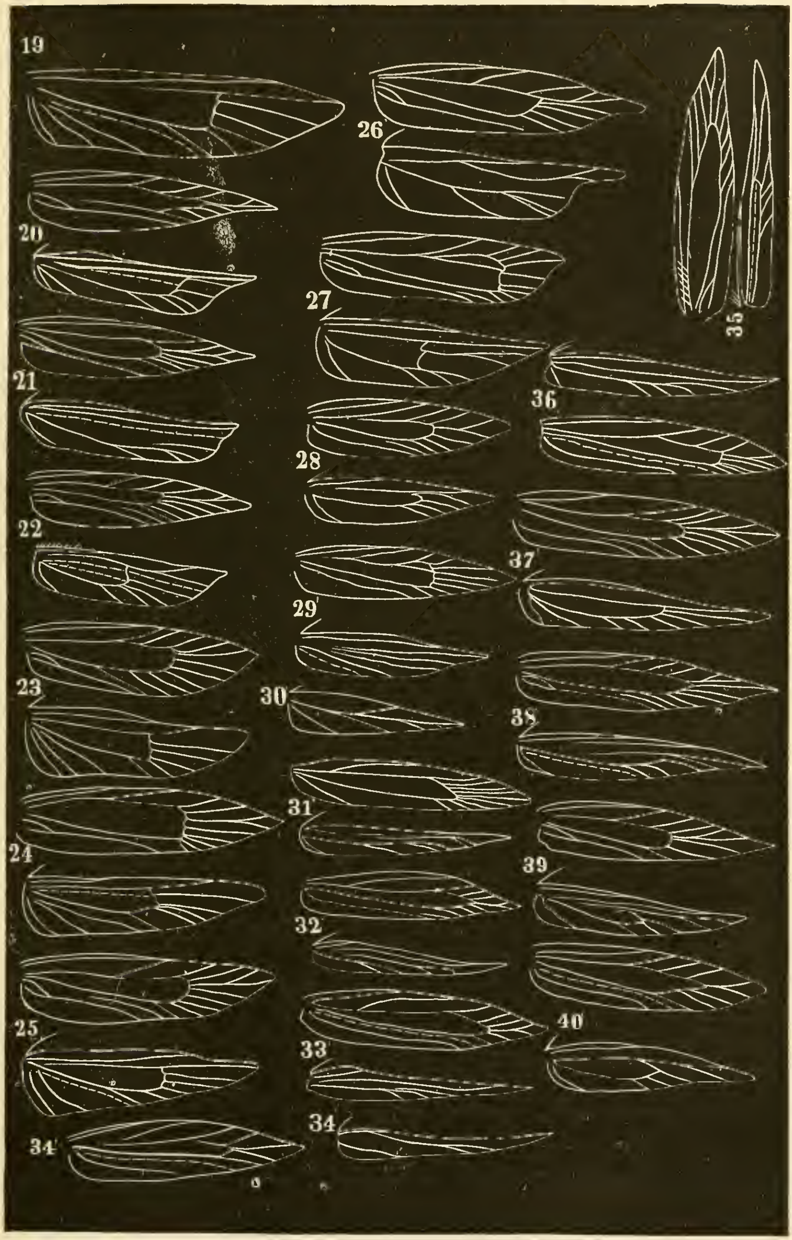
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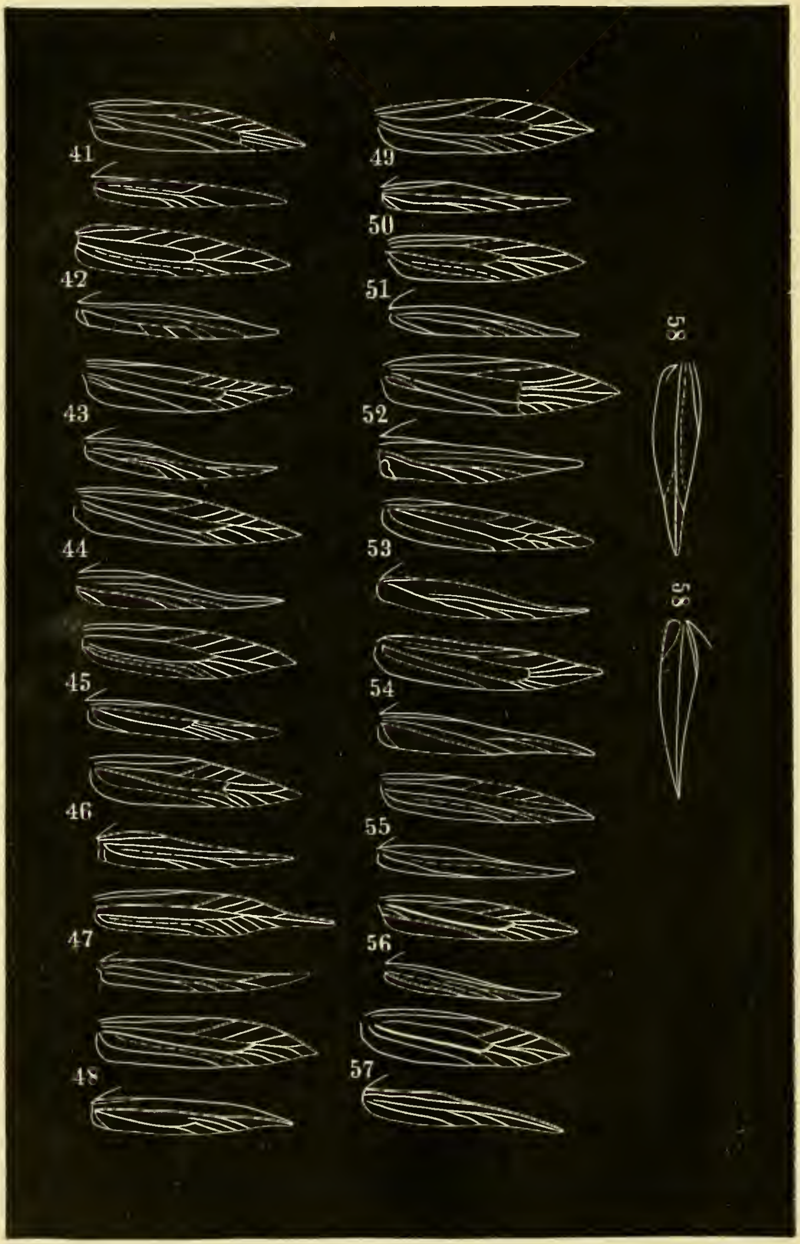
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THREE APPROXIMATE SOLUTIONS OF KEPLER'S PROBLEM.

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Method I.

Prof. Grunert, in his *Neue Naeherungsweise Aufloesung der Kepler'schen Aufgabe*, gives the following equation :

$$\frac{1+e}{1-e} = \frac{\cos\frac{1}{2}\text{M}\sin(\text{E}-\frac{1}{2}\text{M})+\text{F}(\text{E})}{\sin\frac{1}{2}\text{M}\cos(\text{E}-\frac{1}{2}\text{M})-\text{F}(\text{E})}, \tag{1}$$

where e, M and E designate respectively the eccentricity, the mean anomaly, and the eccentric anomaly, while

$$\text{F}(\text{E}) = \tfrac{1}{2}(\text{E}-\text{M}-\sin(\text{E}-\text{M})).$$

Clearing equation (1) of fractions, and reducing it, we have

$$\tan(\text{E}-\tfrac{1}{2}\text{M}) = \frac{1+e}{1-e}\tan\tfrac{1}{2}\text{M} - \frac{2\,\text{F}(\text{E})}{(1-e)\cos\frac{1}{2}\text{M}\cos(\text{E}-\frac{1}{2}\text{M})}. \tag{2}$$

Let $\tan(\text{E}'-\frac{1}{2}\text{M}) = \frac{1+e}{1-e}\tan\frac{1}{2}\text{M}$ and $a = \frac{2}{1-e}$. Substituting and transposing in equation (2) we have

$$\frac{a\,\text{F}(\text{E})}{\cos\frac{1}{2}\text{M}\cos(\text{E}-\frac{1}{2}\text{M})} = \tan(\text{E}'-\tfrac{1}{2}\text{M}) - \tan(\text{E}-\tfrac{1}{2}\text{M}), \tag{3}$$

$$= \frac{\sin(\text{E}'-\text{E})}{\cos(\text{E}'-\frac{1}{2}\text{M})\cos(\text{E}-\frac{1}{2}\text{M})}. \tag{4}$$

$$\therefore \quad \sin(\text{E}'-\text{E}) = \frac{a\cos(\text{E}'-\frac{1}{2}\text{M})}{\cos\frac{1}{2}\text{M}}\,\text{F}(\text{E}). \tag{5}$$

We have also

$$\frac{\sin(\text{E}'-\text{M})}{\cos\frac{1}{2}\text{M}\cos(\text{E}'-\frac{1}{2}\text{M})} = \tan(\text{E}'-\tfrac{1}{2}\text{M}) - \tan\tfrac{1}{2}\text{M}. \tag{6}$$

Since $\tan(\text{E}'-\frac{1}{2}\text{M}) = \frac{1+e}{1-e}\tan\frac{1}{2}\text{M}$, if $q = \frac{2\,e}{1-e}$

$$\sin(\text{E}'-\text{M}) = q\sin\tfrac{1}{2}\text{M}\cos(\text{E}'-\tfrac{1}{2}\text{M}). \tag{7}$$

But

$$\sin(\text{E}'-\text{M}) = \text{E}-\text{M}+\text{E}'-\text{E}-2\,\text{F}(\text{E}'); \tag{8}$$

$$\therefore \quad \text{E}-\text{M} = q\sin\tfrac{1}{2}\text{M}\cos(\text{E}'-\tfrac{1}{2}\text{M})+(\text{E}-\text{E}')+2\,\text{F}(\text{E}'), \tag{9}$$

$$= p\cos\tfrac{1}{2}\text{M}\sin(\text{E}'-\tfrac{1}{2}\text{M})+(\text{E}-\text{E}')+2\,\text{F}(\text{E}'), \tag{10}$$

where $p = q\dfrac{1-e}{1+e} = \dfrac{2\,e}{1+e}$.

Since $F(E) = \frac{1}{12}\sin^3(E-M) + \frac{3}{80}\sin^5(E-M) + \frac{5}{224}\sin^7(E-M) + \ldots$

and F (E′) may be similarly represented, it is evident by reference to (5) that the last two terms of equations (9) and (10) are of the third order, and have opposite signs. If we neglect these terms, the equations will still be approximately true, and we may illustrate their application by the example given in the *Theoria Motus*, Book I., Section 10. With Prof. Grunert, we assume $\tan\,(45^\circ + \omega) = \dfrac{1+e}{1-e}$ where $\tan\omega = e$, and derive the following values of our constants; $\log\tan\,(45^\circ+\omega) = 0{\cdot}2175146$; $\log q = \log e\,(1 + \tan\,(45^\circ+\omega)) = 9{\cdot}8129912$; $\log q$ cosec. $1'' = 5{\cdot}1274163$.

$\frac{1}{2}$ M	164° 52′ 13″·83
log tan $\frac{1}{2}$ M	9·4319633n
log tan (E′—$\frac{1}{2}$M)	9·6494779n
log cos (E′—$\frac{1}{2}$M)	9·9605819n
log sin $\frac{1}{2}$ M	9·4166429
log approx. (E—M)″	4·5046411n
approx. (E—M)	—8° 52′ 42″·53
true (E—M)	—8 52 12·14

Below is a table giving with the arguments φ = arc sin e and M, the sum of the terms (E—E′)+2 F (E′).

E—E′+2 F (E′).

M	φ			M	M	φ			M
	5°	10°	15°			5°	10°	15°	
°	″	″	″	°	°	″	″	″	°
0	0·0	0·0	0.0	360	90	+0·2	+5·0	+33·8	270
15	0·0	— 1·1	— 7·8	345	105	+0·5	+9·2	+45·5	255
30	—0·3	— 5·9	—38·7	330	120	+0·6	+8·6	+37·6	240
45	—0·6	—10·8	—59·2	315	135	+0·4	+5·3	+21·4	225
60	—0·7	— 9·7	—41·2	300	150	+0·2	+2·0	+ 7·7	210
75	—0·3	— 2·8	— 0·2	285	165	0·0	+0·3	+ 1·1	195
90	+0·2	+ 5·0	+33·8	270	180	0·0	0·0	0·0	180

When M exceeds 180°, the signs of the functions in this table must be changed.

Method II.

Substituting x sin (E—M) for F (E) in equation (3) and reducing, we obtain

$$\tan(E'-\tfrac{1}{2}M) - \tan(E-\tfrac{1}{2}M) = (\tan(E-\tfrac{1}{2}M) - \tan\tfrac{1}{2}M)\,ax. \quad (11)$$

A further reduction gives

$$(1+ax)\tan(E-\tfrac{1}{2}M) = \tan(E'-\tfrac{1}{2}M)\left(1+\frac{1-e}{1+e}ax\right). \quad (12)$$

Since $p = \dfrac{2e}{1+e}$,

$$\tan(E-\tfrac{1}{2}M) = \tan(E'-\tfrac{1}{2}M)\left(1-p\,\frac{ax}{1+ax}\right)^*. \quad (13)$$

Equation (13) may be solved by successive approximations, x being the variable; it is preferable, however, to proceed as follows: Neglecting the term $(1+ax)$ and substituting $\dfrac{a}{12}\sin^2(E'-M)$ for ax we have

$$\tan(E-\tfrac{1}{2}M) = \tan(E'-\tfrac{1}{2}M)\left(1-\frac{ap}{12}\sin^2(E'-M)\right). \quad (14)$$

Since $1-z$ is approximately equal to $\dfrac{1}{1+z}$ where z is a small quantity, equation (14) may be written

$$\tan(E-\tfrac{1}{2}M) = \tan(E'-\tfrac{1}{2}M)\,\frac{1}{1+\dfrac{ap}{12}\sin^2(E'-M)}. \quad (15)$$

Employing the previous example for an illustration, we have the following values of our constants; log tan $(45°+\omega) = 0{\cdot}2175146$; log $a = 0{\cdot}42326$; log $\dfrac{1}{p} = 0{\cdot}40452$, which is the function of Zech's subtraction table, corresponding to the argument log tan $(45°+\omega)$; log $\dfrac{12}{ap} = 1{\cdot}06044$.

$\tfrac{1}{2}$ M	164° 52′ 13″·83
log tan $\tfrac{1}{2}$ M	9·4319633n
log tan (E′—$\tfrac{1}{2}$ M)	9·6494779n
E′—$\tfrac{1}{2}$ M	155° 57′ 22″
E′—M	—8 54 52

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* The derivation of this equation was suggested by Prof. Stone.

log sin (E′—M)	9·19022n
log sin² (E′—M)	8·38044
$\log \dfrac{12}{ap \sin^2 (E'-M)}$	2·68000
Zech	0·0009064
log approx. tan (E—½ M)	9·6485715n
approx. (E—½ M)	156° 0′ 2″·05
true (E—½ M)	156 0 1 ·69

It is readily seen from this solution that equation (15) gives exceedingly accurate results. The following table is self-explanatory:

Corrections to values of E, found by equation (15).

M	φ 5°	7°	9°	11°	13°	15°	M
°	″	″	″	″	″	″	°
0	0·00	0·00	0·00	0·00	0·00	0·00	360
20	0·00	—0·01	—0·02	+0·01	+0·04	+0·12	340
40	0·00	0·00	+0·05	+0·18	+0·46	+1·14	320
60	—0·01	0·00	+0·12	+0·33	+0·77	+1·50	300
80	0·00	+0·01	+0·11	+0·20	+0·31	+0·36	280
100	—0·02	+0·02	+0·02	+0·01	—0·08	—0·39	260
120	+0·01	0·00	0·00	—0·02	—0·11	—0·27	240
140	0·00	+0·01	—0·01	—0.01	—0·02	—0·05	220
160	—0·01	0·00	0·00	0·00	0·00	0·00	200
180	0·00	0·00	0·00	0·00	0 00	0·00	180

When M exceeds 180°, the signs of the functions in this table must be changed. The table was formed by subtracting values of E given by equation (15), from those computed in the ordinary manner, using seven-place logarithms, and is, therefore, liable to slight errors in the last decimal place.

Method III.

From equation (7) we deduce

$$\cos\left(E'-\tfrac{1}{2}M\right)=\frac{\sin(E'-M)}{q\sin\frac{1}{2}M}. \qquad (16)$$

Multiplying both members by $\dfrac{a\,F(E)}{\cos\frac{1}{2}M}$ and reducing, we have

$$\frac{2a\sin(E'-M)}{q\sin M}F(E)=a\,\frac{\cos(E'-\frac{1}{2}M)}{\cos\frac{1}{2}M}F(E). \qquad (17)$$

Substituting in (5), we obtain

$$\sin(E'-E)=\frac{2\sin(E'-M)}{e\sin M}F(E). \qquad (18)$$

Assuming

$$\sin(E'-E)=(E'-E)''\sin 1''$$

and

$$F(E)=\frac{1}{12}\sin^3(E'-M),$$

equation (18) becomes

$$(E'-E)''=\frac{\sin^4(E'-M)}{6\,e\sin M\sin 1''}. \qquad (19)$$

This equation may be employed in connection with

$$\tan\left(E'-\tfrac{1}{2}M\right)=\tan(45^\circ+\omega)\tan\tfrac{1}{2}M,$$

or with

$$\sin(E'-M)=q\sin\tfrac{1}{2}M\cos\left(E'-\tfrac{1}{2}M\right).$$

Using it with the former equation, the solution of the previous example is effected as follows: $\log\tan(45^\circ+\omega)=0{\cdot}2175146$; $\log\dfrac{\operatorname{cosec}1''}{6e}=5{\cdot}14655$.

$\frac{1}{2}M$	164° 52′ 13″·83
$\log\tan\frac{1}{2}M$	9·4319633n
$\log\tan(E'-\frac{1}{2}M)$	9·6494779n
$E'-\frac{1}{2}M$	155° 57′ 21″·98
$E'-M$	—8 54 52
$\log\sin(E'-M)$	9·19022n
$\log\sin^4(E'-M)$	6·76088
$\log\operatorname{cosec}M$	0·29765n
log approx. $(E'-E)''$	2·20508n
approx. $(E'-E)$	—2′ 40″·36
true $(E'-E)$	—2 39 ·71

Corrections to values of E, found by Method III.

M	φ 5°	7°	9°	11°	13°	15°	M
°	″	″	″	″	″	″	°
0	0·00	0·00	0·00	0·00	0·00	0·00	360
20	0·00	+0·01	+0·01	—0·02	—0·06	—0·19	340
40	+0·01	—0·01	—0·08	—0·29	—0·84	—2·12	320
60	+0·01	—0·02	—0·19	—0·59	—1·49	—3·24	300
80	0·00	—0·04	—0·17	—0·43	—1·80	—1·57	280
100	0·00	—0·02	—0·05	—0·11	—0·12	—0·03	260
120	0·00	+0·01	0·00	0·00	+0·06	+0·19	240
140	+0·01	0·00	+0·01	+0·01	+0·02	+0·06	220
160	0·00	0·00	0·00	0·00	0·00	0·00	200
180	0·00	0·00	0·00	0·00	0·00	0·00	180

When M exceeds 180°, the signs of the functions in this table must be changed.

The methods here given are intended for use in computing the orbits of minor planets. The corrections given in the tables increase very rapidly as φ increases. An examination of the elements of 200 asteroids, published in the *Berliner Jahrbuch* and its *Circular*, gave the following results:

φ	Number of Asteroids.
0°— 5°	40
5°—10°	86
10°—15°	61
15°—20°	9
$>$20°	4

It is readily seen that the orbits of the great majority of these have $\varphi < 15°$, and that these methods may be rendered useful by enlarging the tables of corrections. It is my intention to develop this subject further, and to publish tables for the use of computers.

ON THE EXTRA-MERIDIAN DETERMINATION OF TIME BY MEANS OF A PORTABLE TRANSIT-INSTRUMENT.

By Ormond Stone, A. M., Astronomer of the Cincinnati Observatory.

It is a well-known fact that in the determination of time by means of a portable transit, the principal source of error is the instability of the instrument. It is important, therefore, that the observations be so arranged that the instrumental errors may be considered constant for as short an interval as possible. On this account it is usual to determine the level error independently for each star. For the determination of the azimuth, transits of at least two stars must be observed in the same position of the instrument; for the determination of the collimation, observations must be made in reversed positions of the horizontal axis. The azimuth may be eliminated by observing in the zenith, or by observing two stars whose declinations are such that

$$\tan\delta' - \tan\varphi = \tan\varphi - \tan\delta,$$

where φ is the latitude of the place. Although these conditions can not in general be rigidly fulfilled, it has been for some time the custom at this Observatory to approximately accomplish the object desired, by observing sets of four stars situated within 20° alternately north and south of the zenith, and, as nearly as may be convenient, at equal distances from it.

One advantage of this method is that pole stars are avoided. When observing in the field it is somewhat inconvenient to adjust the instrument exactly in the meridian, and when this is accomplished, the observer can not always afford to wait for the passage of a circumpolar star. Various methods have therefore been developed for the reduction of observations made in the vertical of the pole star, instead of the meridian. All of these methods are somewhat complicated, and although earnestly recommended by some of the most competent judges, especially within the past few years by Professor Doellen, the distinguished senior astronomer at the Poulkova Observatory, they have not come into general use, except perhaps in Russia. Observations of pole stars are very convenient, and in fact necessary, for the determination of fundamental right ascensions with large fixed instruments, but for the determination of time possess but little advantage, except for purposes of orientation.

Let T $=$ the observed time of transit of a given star over the mean wire,

$\alpha =$ the right ascension of the star,

$\delta =$ the declination of the star,

$\tau =$ the hour angle of the star *east* of the meridian at the time of observation,

$90° - m =$ the hour angle of the point in which the horizontal axis of the instrument produced toward the *west* meets the celestial sphere.

d and $b =$ the declination and altitude of that point.

$g =$ the angular distance of the mean wire from the collimation axis,

$t =$ the clock correction $= \alpha - T - \tau$.

Then, putting $n = \tan d$, and $c = \sin g \sec n$, and neglecting b, since it may be applied directly to the reading of the clock, we have

$$\sin m = -n \tan \varphi, \qquad (1)$$

$$\sin (\tau - m) = n \tan \delta + c \sec \delta, \qquad (2)$$

where c is usually very small. For a star whose declination is δ',

$$\sin (\tau' - m) = n \tan \delta' + c \sec \delta'. \qquad (3)$$

Adding (1) to each of the equations (2) and (3), and differentiating, we have

$$\cos (\tau - m)\, d\tau + [\cos m - \cos (\tau - m)]\, dm = (\tan \delta - \tan \varphi)\, dn + \sec \delta\, dc, \qquad (4)$$

$$\cos (\tau' - m)\, d\tau' + [\cos m - \cos (\tau' - m)]\, dm = (\tan \delta' - \tan \varphi)\, dn + \sec \delta'\, dc, \qquad (5)$$

where if the stars are observed near the zenith, and the instrument is not too far from the meridian, we may assume

$$\cos m = \cos (\tau - m) = \cos (\tau' - m) = 1.$$

Assuming also,

$$\sin m_1 = -n_1 \tan \varphi, \qquad (6)$$

$$\sin (\tau_1 - m_1) = n_1 \tan \delta, \qquad (7)$$

$$\sin (\tau_1' - m_1) = n_1 \tan \delta', \qquad (8)$$

where m_1, n_1, τ_1 and τ_1' are approximate values of m, n, τ and τ', we have

$$\tau - \tau_1 = (n - n_1)(\tan \delta - \tan \varphi) + c \sec \delta, \qquad (9)$$

$$\tau' - \tau_1' = (n - n_1)(\tan \delta' - \tan \varphi) + c \sec \delta'. \qquad (10)$$

For a second series of approximate values, m_2, n_2, τ_2 and τ_2' which satisfy the condition $t_2 = a - \mathrm{T} - \tau_2 = a' - \mathrm{T}' - \tau_2'$, we have

$$\sin m_2 = -n_2 \tan \varphi, \tag{11}$$

$$\sin (\tau_2 - m_2) = n_2 \tan \delta, \tag{12}$$

$$\sin (\tau_2' - m_2) = n_2 \tan \delta'; \tag{13}$$

$$\therefore \quad \tau - \tau_2 = (n - n_2)(\tan \delta - \tan \varphi) + c \sec \delta = t_2 - t \tag{14}$$

$$= \tau' - \tau_2' = (n - n_2)(\tan \delta' - \tan \varphi) + c \sec \delta'; \tag{15}$$

$$\tau_2 - \tau_1 = (n_2 - n_1)(\tan \delta - \tan \varphi), \tag{16}$$

$$\tau_2' - \tau_1' = (n_2 - n_1)(\tan \delta' - \tan \varphi). \tag{17}$$

Adding (6) successively to (7) and (8) we have approximately,

$$\tau_1 = n_1 (\tan \delta - \tan \varphi), \tag{18}$$

$$\tau_1' = n_1 (\tan \delta' - \tan \varphi). \tag{19}$$

$$\therefore \quad \frac{\tau_2 - \tau_1}{\tau_1} = \frac{\tau_2' - \tau_1'}{\tau_1'} = \frac{n_2 - n_1}{n_1} = \nu. \tag{20}$$

Also, if

$$t_1 = a - \mathrm{T} - \tau_1, \tag{21}$$

and

$$t_1' = a' - \mathrm{T}' - \tau_1', \tag{22}$$

we have

$$t_2 = t_1 - (\tau_2 - \tau_1) = t_1' - (\tau_2' - \tau_1')$$

$$= t_1 - \tau_1 \nu = t_1' - \tau_1' \nu, \tag{23}$$

whence

$$\nu = \frac{t_1' - t_1}{\tau_1' - \tau_1}. \tag{24}$$

In the same manner, for two stars observed in the reversed position of the horizontal axis,

$$t_2'' = t_1'' - \tau_1'' \nu'' = t_1''' - \tau_1''' \nu'', \tag{25}$$

whence,

$$\nu'' = \frac{t_1''' - t_1''}{\tau_1''' - \tau_1''}. \tag{26}$$

Equations (14) and (15) give,

$$n - n_2 = c \, \frac{\cos \delta' - \cos \delta}{\sin (\delta' - \delta)}. \tag{27}$$

$$\therefore \quad t = t_2 - c \sec \varphi \, \frac{\cos \frac{1}{2}(z' - z)}{\cos \frac{1}{2}(z' + z)}, \tag{28}$$

where $z = \varphi - \delta$ and $z' = \delta' - \varphi$, assuming $\delta' > \varphi > \delta$, and for the stars observed in the opposite position of the horizontal axis,

$$t = t_2'' + c \sec \varphi \frac{\cos \frac{1}{2} (z''' - z'')}{\cos \frac{1}{2} (z''' + z'')}, \qquad (29)$$

where

$$z'' = \varphi - \delta'', \; z''' = \delta''' - \varphi \text{ and } \delta''' > \varphi > \delta''.$$

Assuming that the stars observed are not far from the zenith, and neglecting small quantities, we have

$$c \sec \varphi = \tfrac{1}{2} (t_2 - t_2''), \qquad (30)$$

$$\frac{\cos \frac{1}{2} (z' - z)}{\cos \frac{1}{2} (z' + z)} = \frac{1 - 2 \sin^2 \frac{1}{4} (z' - z)}{1 - 2 \sin^2 \frac{1}{4} (z' + z)}$$

$$= 1 - 2 \left(\sin^2 \tfrac{1}{4} (z' - z) - \sin^2 \tfrac{1}{4} (z' + z) \right)$$

$$= 1 + 2 \sin \tfrac{1}{2} z \sin \tfrac{1}{2} z', \qquad (31)$$

$$\frac{\cos \frac{1}{2} (z''' - z'')}{\cos \frac{1}{2} (z''' + z'')} = 1 + 2 \sin \tfrac{1}{2} z'' \sin \tfrac{1}{2} z'''. \qquad (32)$$

$\therefore$ taking the mean of (28) and (29)

$$t = \tfrac{1}{2} (t_2 + t_2'') + \tfrac{1}{2} (t_2 - t_2'') (\sin \tfrac{1}{2} z'' \sin \tfrac{1}{2} z''' - \sin \tfrac{1}{2} z \sin \tfrac{1}{2} z'); \quad (33)$$

or, if

$$Z = 2 \frac{\sin \frac{1}{2} z}{\sin 1^\circ},$$

$$Z' = 2 \frac{\sin \frac{1}{2} z}{\sin 1^\circ},$$

$$Z'' = 2 \frac{\sin \frac{1}{2} z''}{\sin 1^\circ},$$

$$Z''' = 2 \frac{\sin \frac{1}{2} z'''}{\sin 1^\circ},$$

$$t = \tfrac{1}{2} (t_2 + t_2'') + 0{\cdot}000038 (t_2 - t_2'') (Z'' Z''' - Z Z'), \qquad (34)$$

in which Z, Z', Z'', Z''' may be assumed to be the zenith distances expressed in degrees.

After making the preliminary reductions and correcting for level error, we may assume for the first approximation,

$$n_1 = -\frac{\sin (\alpha' - \mathrm{T}' - (\alpha - \mathrm{T}))}{\tan \delta' - \tan \delta} \text{ or } \frac{\sin(\alpha''' - \mathrm{T}''' - (\alpha'' - \mathrm{T}''))}{\tan \delta''' - \tan \delta''}. \qquad (35)$$

With this value of n_1 compute

$$\sin m_1 = - n_1 \tan \varphi, \qquad (36)$$

and for each star

$$\sin(\tau_1 - m_1) = n_1 \tan \delta, \tag{37}$$

$$\tau_1 = (\tau_1 - m_1) + m_1, \tag{38}$$

$$t_1 = \alpha - \mathrm{T} - \tau_1. \tag{39}$$

Then from the stars observed in each position of the horizontal axis, compute

$$\nu = \frac{t_1{}' - t}{\tau_1{}' - \tau_1}, \tag{40}$$

$$\nu'' = \frac{t_1{}''' - t_1{}''}{\tau_1{}''' - \tau_1{}''}, \tag{41}$$

$$t_2 = t_1 - \tau_1\,\nu = t_1{}' - \tau_1{}'\,\nu, \tag{42}$$

$$t_2{}'' = t_1{}'' - \tau_1{}''\,\nu'' = t_1{}''' - \tau_1{}'''\,\nu''. \tag{43}$$

In other words, if t_1 does not agree with $t_1{}'$ the difference must be divided proportionally to τ_1 and $\tau_1{}'$. In the same manner the difference between $t_1{}''$ and $t_1{}'''$ must be divided proportionally to $\tau_1{}''$ and $\tau_1{}'''$. Finally the clock correction is to be derived from the formula

$$t = \tfrac{1}{2}\,(t_2 + t_2{}'') + 0{\cdot}000038\,(t_2 - t_2{}'')\,(\mathrm{Z}''\,\mathrm{Z}''' - \mathrm{Z}\,\mathrm{Z}'), \tag{44}$$

the last term of which is an exceedingly small quantity, and although easily computed, it may generally be neglected, if the collimation is small and a little care is taken to select stars which will give Z″ Z‴ approximately equal to Z Z′. In fact it may readily be seen that for $t_2{}'' - t_2 = 0^s.66$, and for stars within 20° of the zenith the last term of (42) can never exceed $0^s.01$.

If the observer sweep in altitude and azimuth until Polaris is near the center of the field of the telescope, and the latitude and time be approximately known, approximate values of $\tau - m$, $\acute{m}$ and t may be readily obtained for each star from auxiliary tables; these will be found convenient for setting purposes and for the determination of n_1. Such tables have been kindly prepared for me by Mr. Howe.

A portable transit is often used in a fixed observatory for the determination of time, and since it may be kept nearly in the meridian, n_1 may be assumed equal to zero, and the differences between t_1 and $t_1{}'$ or $t_1{}''$ and $t_1{}'''$ divided proportionately to tabulated values of $\tan\delta - \tan\varphi$.

EXAMPLE.

On the 5th of December, 1878, Mr. Howe by sweeping brought Polaris into the field of a Buff and Berger transit, and observed in both positions of the horizontal axis. The resulting clock times, and the scheme of computation are given below. From α Pegasi and λ Andromedæ, we have

$$\varphi = 39° 8' 20''$$
$$\log n_1 = 8.20291$$
$$m_1 = + 2^{m} 58^{s}{\cdot}56.$$

	LAMP EAST.		LAMP WEST.	
Name of Star.	μ Pegasi.	o Andromedæ.	α Pegasi.	λ Andromedæ.
δ	23° 57′ 59″	41° 40′ 50″	14° 33′ 27″	45° 48′ 27″
Time of Transit	$22^h\ 46^m\ 7^s{\cdot}66$	$22^h\ 56^m\ 40^s{\cdot}93$	$23^h\ 1^m\ 23^s{\cdot}19$	$23^h\ 31^m\ 29^s{\cdot}16$
Level	+0 ·16	+0 ·20	+0 ·16	+0 ·23
Aberration ...	—0 ·02	—0 ·02	—0 ·02	—0 ·02
Clock rate ...	+0 ·01	0 ·00	0 ·00	—0 ·02
T	$22^h\ 46^m\ 7^s{\cdot}81$	$22^h\ 56^m\ 41^s{\cdot}11$	$23^h\ 1^m\ 23^s{\cdot}33$	$23^h\ 31^m\ 29^s{\cdot}35$
α	22 44 10 ·08	22 56 21 ·56	22 58 44 ·54	23 31 39 ·26
α—T	—1 57 ·73	—19 ·55	—2 38 ·79	+9 ·91
log tan δ	9·64790	9·94957	9·41445	0·01224
log sin$(\tau_1—m_1)$	7·85081	8·15248	7·61736	8·21515
$\tau_1—m_1$	+1 37·53	+3 15·35	+0 56·98	+3 45·68
τ_1	—1 21·03	+0 16·79	—2 1·58	+0 47·12
t_1	— 36·70	— 36·34	— 37·21	— 37·21
t_2	— 36·40		— 37·21	
t	— 36·80			

In this case the last term of (44) is only $0^s.0046$.

SILURIAN ICHNOLITES, WITH DEFINITIONS OF NEW GENERA AND SPECIES.

By S. A. Miller, Esq.

We find drifted sedimentary lines and markings, the trails of fucoids, and the trails and tracks of mollusca and crustacea well preserved, on the greenish-blue and bluish slaty shales of the age of the Utica Slate, and upon the shales of what may be regarded as the passage beds from the Utica Slate to the Hudson River Group, at and near the city of Cincinnati. The drifted lines and markings have never been studied or illustrated. Some of them resemble the schematical figures of the trails of drifting fucus, as described and illustrated by the Swedish Geologist, Alfred Nathorst, in "Ofversigt af Kongl. Vetenskaps-Akademiens Forhandlingar," 1873, pp. 25 to 52, pl. 15 to 17. And some of them may have been described, possibly, as fucoids.

No attempt has ever been made to describe the trails and tracks of the mollusca and crustacea found upon these rocks, with the exception of an illustration by the author in the *Cin. Quar. Jour. Sci.*, vol. i., p. 136, in 1874, which is reproduced in this article. It is absolutely necessary, in order to distinguish these impressions, in conversation or in writing, that names should be applied to them, and I think, therefore, I may be excused for giving them generic and specific names, as no harm can result from such a course. This has been done with success in regard to the vertebrate tracks in more recent rocks, and I see no insuperable objection to attempting it with the invertebrate trails and tracks now under consideration.

Asaphoidichnus, n. gen.

This genus consists of two rows of tracks; one representing the impressions made by the feet upon the right side of the animal, and the other the impressions made by the feet upon the left. The tracks are separate and distinct, showing that the animal lifted its feet to advance, and appearing as if made by an articulated animal, but not by one holding its feet in an inflexible position. The anterior part of each track is divided and usually thrown outward. The tracks follow each other whether the course is direct or sinuous.

By the generic name, I have intended to indicate that I am dealing with such a track as I suppose an Asaphus may have made.

I suppose these tracks may have been made at the bed of an ocean

having no great depth, but where the water was almost motionless, part of the time, and at other times very slightly disturbed. The delicately drifted sediment, and fine fucoidal trails, indicate the slightest disturbance of the water; while the fine sediment of which the slaty shales is composed, and the preservation of the tracks indicate that the weight of the animal pressed the feet into the sediment which retained the impressions without disturbance from moving water until they were filled by the slowly precipitated impalpable powder that fell upon the bed of the sea.

Asaphoidichnus trifidus.

Asaphoidichnus trifidus, n. sp.

In this species the anterior third of each track is trifid, the outer toe usually branching from the main stem of the track first, and the middle toe being a little longer than either the outer or inner one. The illustration is from the *Cin. Quar. Jour. Sci.*, as above stated, but specimens better preserved have been collected by Mr. Dyer, and show a small toe thrown off from the posterior elevation on the inner side of the track, having a length about equal to the inner anterior toe. The illustration represents the tracks of the right feet. The difference in distance between the rows of tracks in different specimens examined varies from $1\frac{1}{4}$ to 3 inches, and there is a corresponding difference in the size of the tracks. The tracks are usually turned outward, but some times they are directed straight in the line of the course of the tracks; in the latter case they are more distant from each other than in the former. The middle part of a track is a simple elevated line. The posterior part consists of an elevation, with a toe upon the inner side as above remarked.

A well preserved track, in a specimen having a distance of 2 1-5 inches between the two rows, measured between the posterior part of the tracks, has the following dimensions: Length, 0.52 inch; length of inner anterior and posterior toe, each, 0.13 inch; length of outer posterior toe, about the same; length of middle anterior toe, 0.15 inch. In a specimen having a distance of 1.5 inches between the rows, a track has a length of 0.42 inch.

This species was first collected by C. B. Dyer, on

Walker Mill Road, at an elevation of less than 100 feet above low-water mark at Cincinnati, in shales of the age of the Utica Slate.

Asaphoidichnus dyeri, n. sp. (Plate XIII., fig. 1, natural size.)

The tracks upon the left side (in the specimen illustrated, and in all other specimens which have been observed), are placed somewhat in advance of those upon the right side, and they are also more distinctly defined. Each track upon the left has four toes — the left or outer toe is the longer and the right or interior toe the shorter. The toes do not come together as in *A. trifidus*, but spring from a wider foot. Some of the toe-tracks are more or less fringed, which I attribute to the action of the water, though Mr. Dyer is impressed with the idea that it may indicate hairy or spinous feet. The tracks made by the right feet are hardly definable, as in all our specimens the feet seem to have dragged more or less upon this side.

It may be that this species should be referred to another genus, but after examining five slabs having the tracks upon them, I have concluded to leave it in this genus, where it seems, at least, to have some affinity.

The species was collected by C. B. Dyer, Esq., on the Walker Mill Road, in Cincinnati, and is from his collection. The specific name is intended as a slight recognition of his many years of service to the science.

Trachomatichnus, n. gen.

[Ety.—*Trachoma*, that which is made rough; *ichnos*, a track.]

This genus is proposed for the reception of the trails of molluscan animals of an uncertain class, but possibly belonging to the Cephalapoda. The reason for suggesting the Cephalapoda is that the *Orthoceras*, *Endoceras*, *Cyrtoceras* and *Trocholites*, which are found in these rocks, were large enough to have made such trails, and we know of no genus in any other class that seems to have been capable of making such. The trail consists of numerous, simple or compound impressions, arranged in two series or rows which are separated by an intervening space of greater or less width.

Trachomatichnus numerosus n. sp. (Plate XIII., figs. 2, 3 and 4.)

In this species the width of a series or row is equal to or greater than the distance between the two series which form the trail. The

tracks or impressions in each series are compound, or, in other words, they are composed of four or five parts, which present a beaded appearance. The arrangement of the compound or beaded track is either transverse to the course of the trail, or inclined forward from the inner to the outer side. The tracks are as close together in each series as they can well be placed without commingling, and in some specimens form almost a continuous trail. Figures 2 and 3 represent the casts from the impressions made by the moving animal, but figure 4 shows the trail itself in the rock. This trail is, we may presume, just as the animal made it. It is as distinct as if made but yesterday.

It is not unusual to find trails crossing each other, as may be seen in the lower part of figure 2. In this case the animal that made *T. permultus*, crawled along on the mud first, and afterward the animal that made *T. numerosus*, crossed its trail, obliterating *T. permultus*, or throwing the tracks into confusion where they came in contact, but leaving them between the series uninjured. (The illustration does not show this peculiarity as distinctly as the specimen does.)

Collected by C. B. Dyer, in rocks of the age of the Utica Slate, on Walker Mill Road, in the City of Cincinnati.

TRACHOMATICHNUS PERMULTUS, n. sp. (Plate XIII., fig. 5.)

This species consists of impressions arranged in two rows, which are separated by a space that is wider than a row of tracks. The tracks are subtriangular, wider than long, and indicate a slight dragging of the feet at the central posterior part.

It is distinguished from *T. numerosus*, because the tracks are not so numerous, they are destitute of the beaded appearance, they are subtriangular instead of somewhat uniformly rounded, and the rows are proportionally farther apart.

The lower part of fig. 5 shows some extra markings upon the left side, which may indicate that some other part of the body occasionally touched the bottom of the sea, or they may belong to another trail which is nearly obliterated.

Collected by C. B. Dyer, in rocks of the age of the Utica Slate, on Walker Mill Road, in the City of Cincinnati.

TRACHOMATICHNUS CINCINNATENSIS, n. sp. (Plate XIV., fig. 3.)

This species consists of numerous simple impressions, arranged in two series, which are widely separated from each other. The impressions are small, and possess no well defined characters. The species is distinguished from *T. permultus* by the smaller and more ill-defined

form of the tracks, by the greater number in each series, and by the greater distance between the two series. It is distinguished from *T. numerosus* by the greater distance between the series, by the less number of impressions in each series, and by the simple character of the tracks instead of the compound or beaded form.

I think the three species of tracks may be readily distinguished, and yet they were likely made by animals closely allied, and belonging to the same family, if not to the same genus. Different species of *Orthoceras*, if they ever made tracks upon the bed of an ocean, would probably make tracks as distinct from each other as these, and possibly much more distinct.

Collected by C. B. Dyer, in rocks of the age of the Utica slate, on Walker Mill Road, in the City of Cincinnati.

Teratichnus, n. gen.

[Ety.—*Teras*, a wonder; *ichnos*, a track or trace.]

This genus is proposed for a singular trail, which we suppose may have been made by some animal belonging to the class Cephalopoda. It consists of numerous elongated more or less bifurcated impressions, which are crowded together upon the right side and separated upon the left. They are directed forward from the right side toward the left, and may possibly be separable into two rows.

Teratichnus confertus, n. sp. (Plate XIV., fig. 1, natural size.)

This species is founded upon a single specimen. The impressions of the trail are long, some of them are bifurcated; they are crowded or blended together upon the right side, and expanded or separated upon the left. The impressions are directed forward from the right toward the left side, though not continuous from one side to the other. They are, however, so interlocked that they are not separable into two definable rows.

The illustration shows that the tracks after turning the arc of a circle are blended or confused. Here we have the evidence that the animal backed and changed its course. Beyond this the specimen preserves only part of the trail.

Collected by C. B. Dyer, Esq., in rocks of the age of the Utica Slate, on Walker Mill Road, in Cincinnati.

Petalichnus, n. gen.

[Ety.—*Petalos*, spread out; *ichnos*, a track.]

This genus is also proposed for the reception of trails that may, pos-

sibly, have been made by the Cephalopoda. It consists of a wide trail, composed of numerous transversely-elongated depressions, arranged apparently without definite order, but equivalent to three or more interlocking rows.

PETALICHNUS MULTIPARTITUS, n. sp. (Plate XIV., fig. 2, natural size.)

This species consists of a wide trail, formed by four or five irregularly-arranged, transversely-elongated tracks, following each other without definite order. One track so interlocks with another by an alternate arrangement that the trail is not susceptible of division into definite rows. A single track is a simple elongated depression, transverse to the course of the trail.

Collected by C. B. Dyer, Esq., in rocks of the age of the Utica Slate, on Walker Mill Road, in Cincinnati, at an elevation of less than 100 feet above low-water mark of the Ohio river.

ORMATHICHNUS, n. gen.

[*Ety.—Ormathos*, a string of beads; *ichnos*, a track.]

This genus is proposed for the reception of trails which I suppose may have been made by a Gasteropod. It consists of a single, continuous, beaded track or trail.

ORMATHICHNUS MONILIFORMIS, n. sp. (Pl. XIV., figs. 4 and 5, natural size.)

This species consists of a simple beaded trail, resembling somewhat the impression made by a small column of *Heterocrinus simplex*, though longer beaded. Fig. 4 illustrates it. I have also referred fig. 5 to the same species, though it has a longitudinal furrow in the middle, and I am at a loss to account for the furrow if made by the same species. Collected by C. B. Dyer, Esq., in rocks of the age of the Utica Slate, on the Walker Mill Road in Cincinnati.

In 1852, Prof. Hall illustrated a number of tracks and trails (Palæontology of N. Y., vol. 2) from the Clinton Group of Herkimer and Oneida counties, New York. Those, which he suggested might have been made by some of the Gasteropoda, bear little or no resemblance to any of the species described in this article; but some of those which he thought might have been made by Crustacea or fishes may be compared with those here described and supposed to have been made by Cephalopoda. He was inclined to believe that many of the tracks he illustrated were made while the bed was exposed above water and most of the others in very shallow water, while I have expressed the opinion that the tracks here described were made on the bottom of the sea at considerable depth.

NORTH AMERICAN MESOZOIC AND CÆNOZOIC GEOLOGY AND PALÆONTOLOGY.

By S. A. Miller, Esq.

[*Continued from page 161.*]

Dr Joseph Leidy* described, from the Triassic rocks of Star Canon. Humboldt county, and from Toiyabe Range northeast of Austin, Nevada, *Cymbospondylus petrinus*, *C. piscosus* and *Chonespondylus grandis*. And Prof. E. D. Cope, from Chatham county. North Carolina, the batrachian *Pariostegus myops*.

In 1869, T. A. Conrad† referred the clays on the Raritan river, in New Jersey, which are found at the base of the Cretaceous, to the Triassic, and described *Podozamites proximus* and *Palæocypris trinodiferus*. He described from South river,‡ New Jersey, *Astarte veta*, and *A. annosa*, and from Perkiomen Creek, Pa.,§ *Solenomya triasina*.

Prof. E. D. Cope,‖ from the Triassic at Phoenixville, on the Schuylkill river. Pa., the Saurian *Belodon lepturus*.

In 1870, W. M. Gabb¶ described, from New Pass, near Austin, and in the slates of Star Canon, *Cardinia ponderosa*, *Posidonomya blatchleyi*, *Cassianella lingulata* and *Monotis circularis*. And from the Jurassic of the mining district of Volcano, in Nevada, *Ammonites nevadensis*, *Turbo regius*, *T. elevatus*, *Pholadomya multilineata*, *P. nevadana*, *Goniomya aperta*, *Cardium arciformis*, *Astarte appressa*. *Plicatula perimbricata*, and *Spirifera obtusa*; and from the slates on the west slope of the Sierra Nevada, near Colfax, *Ammonites colfaxi*.

In 1871, Prof. J. W. Dawson** described from the Trias of Prince Edward Island, *Dadoxylon edwardanum* and *Cycadoidea abequidensis*.

In 1872,†† he said the Trias of Prince Edward Island is represented principally by bright red sandstone, sometimes mottled with white and associated occasionally with beds of gray and white sandstone. Subordinate to these sandstones are beds of red and mottled clay, of reddish concretionary and conglomerate limestone, sometimes dolomitic. and of reddish conglomerate with quartz pebbles and arenaceous

* Proc. Acad. Nat Sci.
† Am. Journal Sci. and Arts, 2d series, vol. 47,
‡ Am, Jour. Conch., vol. 4.
§ Am. Jour. Conch., vol. 5.
‖ Trans. Am. Phil. Soc.
¶ Am. Jour. Conch., vol. 5.
** Report on Prince Edward Island.
†† Lond. Geo. Mag., vol. 9.

cement. These beds undulate in low synclinals and anticlinals, having in general a northeast and southwest direction, and rise in some places to an elevation of 400 feet above the sea. They are probably about 500 feet in thickness. The lower half of this thickness, which contains the limestone beds, and also certain hard beds of conglomerate and concretionary calcareous sandstone, may be regarded as an equivalent of the Bunter Sandstone ; while the upper portion, consisting principally of soft red sandstone, with some beds of fine grained conglomerate may be regarded as corresponding to the Keuper.

These beds rest conformably upon the newer coal measures without the intervention of the Permian. They appear to have been deposited in a shallow sea area, not improbably coincident with the Southern Bay of the Gulf of St. Lawrence, limited to the north by the Magdalen Islands and the banks in their vicinity, which represent an old Lower Carboniferous outcrop. Their materials were derived from the waste of red sandstones and marls of the Carboniferous, and have been thrown down with sufficient rapidity to prevent the coating of red oxide of iron from being removed by abrasion, or by the chemical action of organic matter. The dolomitic character of some of the coarse limestones may either indicate the occurrence of occasional isolated basins and depositions of magnesia from sea water, or may have been connected with the outburst of igneous matter in magnesia, like the dolerite of Hog Island, near to which place the beds richest in magnesia were observed.

In 1872, F. B. Meek* described from the Jurassic, at Lincoln Valley, near Fort Hall, Idaho, *Aviculopecten idahoensis*.

In 1873, Dr. F. V. Hayden estimated the thickness of the Jurassic, on the Missouri, below the Canon at the Three Forks at 1,500 feet. A section, in Spring Canon, on the headwaters of the Gallatin river in Montana, of limestones, sandstones, quartzites and conglomerates, displays a thickness of 425 feet, followed below by 65 feet of Triassic age.† And F. B. Meek described from Montana *Gervillia montanensis*, *Goniomya montanensis*, *Myacites subcompressus*, *Pholadomya kingi*, *Trigonia americana*, *T. montanensis*, and *Volsella subimbricata*.

In 1874, Dr. Hayden‡ estimated the thickness of the Triassic on Eagle river, consisting of brick-red sandstones and clays at from 1,200 to 1,500 feet, and above them 200 feet or more of Jurassic rocks, suc-

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* 5th Rep. Hayden's U. S. Geo. Sur. Terr.
† 6th Rep. Hayden's U. S. Geo. Sur. Terr.
‡ 7th Rep U. S. Geo. Sur. Terr.

ceeded by a quartzite belonging to the Dakota Group, having a thickness of 150 feet. At Little Thompson's creek it consists of soft granite sandstones and conglomerates below, followed by red, shaly and massive sandstones above, and reposes upon the smoothed and often irregular surface of Archaean rocks. It has a thickness of 750 feet. It thins out north of Golden City, where it has a thickness of scarcely 400 feet, but rapidly thickens in its extension southward to where the South Platte debouches from the mountains; here it attains a thickness of 1,600 feet. Dr. A. C. Peale's section through Pleasant Park represents its thickness at 1,580 feet, and from Glen Eyrie eastward to Camp creek, 1,280 feet.

A section of the Jurassic rocks, taken by Wm. H. Holmes near Saint Vrain's Creek, gave a thickness of between 400 and 500 feet; and another in Bear Canon, 870 feet; another near Ralston creek, 660 feet; and another near Bear Creek, 770 feet. Dr. A. C. Peale's section through Pleasant Park furnishes a thickness of about 461 feet, and from Glen Eyrie eastward to Camp Creek, 405 feet.

Prof. E. D. Cope* detected the first vertebrate fossils in the Trias of the Rocky Mountains of New Mexico, including carnivorous Saurians and Unionidæ, the latter indicating a lacustrine deposit.

In North Carolina † there are two narrow fringes of an eroded and obliterated anticlinal which belong to the Triassic; the smaller or Dan river belt, from 2 to 4 miles wide, following the trough-like valley of that stream, about N. 65° E. for more than 30 miles, to the Virginia line, and then extending into Virginia about 10 miles; the other, the Deep river belt, extending in a similar trough 5 to 15 miles wide (and depressed 100 to 200 feet below the general level of the country), from the southern boundary of the State in Anson county, in a N. E. direction, to the middle of Granville county, within 15 miles of the Virginia line. They are separated, therefore, by a swell of country 75 to 100 miles wide, which rises along its topographical axis to 800 or 900 feet above the sea, the troughs themselves having respectively an elevation of 500 to 600 feet, and 200 to 300 feet. The belts are convergent in the direction of the Triassic beds of Virginia, with which they were doubtless once connected (as well as with some small intervening outliers) in one continous formation.

The dip of the Dan river beds is about 35° N. W. (20° to 70°) and those of Deep river, 20° S. E. (10° to 35°). The rocks are sandstones,

* Proc. Am. Phil. Soc.

† Kerr's Geo. of N. Carolina, 1875. Emmons Geo. Sur. 1856.

clay slates, shales and conglomerates, generally ferruginous and brick red, but often gray and drab. The shales are occasionally marly, and these and the sandstones are sometimes saliferous. Many of the beds consist of loose and uncompacted materials, and are therefore easily abraded.

The most important and conspicuous member of the series, is a large body of black shales, which enclose seams of bituminous coal 2 to 6 feet. This coal lies near the base of the system in both belts, and is underlaid on Dan river by shales; and on Deep river by sandstones and conglomerates; the latter constituting the lowest member of the series, and being in places very coarse. And near the eastern margin in Wake county, where the belt reaches its greatest breadth (some 15 miles), the conglomerates are of great thickness and very coarse, uncompacted and rudely stratified, resembling somewhat the half stratified drift of the mountain slopes, the fragments often little worn, and sometimes 10 to 12 inches in diameter, and evidently derived from the Huronian rocks of the hills to the eastward. The conglomerates of the Dan river belt are among the upper members of the series, and are mostly fine and graduating to grits and sandstones.

The black shales near the base of the system contain beds of fire clay and black band iron ore, interstratified with the coal. They are also highly fossiliferous, especially on Deep river. Silicified trunks of trees are very abundant in the lower sandstones, as may be seen conspicuously near Germantown, in Stokes county, the public road being in a measure obstructed by the multitude of fragments and entire trunks and projecting stumps of a petrified Triassic forest; and similar petrifactions are abundant in the Deep river belt, occurring in this, as in the other, among the sandstones near the horizon of the coal.

The actual vertical depth to the underlying Archæan rocks on Dan river may not exceed 1000 feet, but what was the original thickness of the strata before denudation began can only be conjectured. The beds on Dan river, however, measured at right angles to the dip, gives a minimum thickness for that side of the formation of near 10,000 feet. In the section of the Deep river belt, which is exposed in the valley of the Yadkin, not only is there a width of six miles with the usual dip of 20°, but there is an additional outcrop more than a mile in breadth, *ten miles south* of the principal belt, which preserves the southeasterly dip of nearly 20°, and hence the calculation for a minimum thickness, at this margin, must be based on a breadth of 16 miles, which gives a thickness of more than 25,000 feet.

There is no way of accounting for the present position of these beds

with their opposite and considerable dips, but by supposing an uplift of the intervening tract, such and so great, that if the movement were now reversed, it would carry this swell of nearly 100 miles breadth into a depression much below the present level of the troughs in which these remnant fringes lie, so that there has been an erosion not only of 10,000 to 20,000 feet of the broken arch of Triassic beds over this area but also of a considerable thickness of the underlying rocks on which they had been deposited.

The present area of Triassic in North Carolina is about 1,000 square miles, about one third of which, it is estimated, is underlaid with coal.

Prof. G. K. Gilbert* found a section of the Trias exposed by the North fork of Virgin river, from the vicinity of Mountain Lakelet to Rockville, in Southern Utah, 3,250 feet in thickness, and the Jurassic at the same place 350 feet. The Triassic on the West Fork of Paria Creek, 2,575 feet, and the Jurassic 740 feet. And the Triassic at Jacob's Pool, Northern Arizona, 2,150 feet in thickness. E. E. Howell estimated the Trias at Rock Canon, near Provo in the Wahsatch Range, at from 4,000 to 5,000 feet, and the Jurassic from 6,000 to 8,000 feet. On Pine Mountain, the Trias at 4,650 feet, and the Jurassic at 1,200 feet.

On the Dirty Devil river in Northern Utah, the Jurassic is about 800 feet thick, on the southwest side of Escalante river, 60 miles farther south, from 1,000 to 1,200 feet. The thickness of the Triassic in New Mexico and Eastern Arizona is from 1,200 to 1,800 feet. This gradually increases to the westward until near Paria, it is 2,250 feet Ninety miles to the northeast, on the Dirty Devil river, 1,700 to 1,900 feet, is found, while near St. George, farther west, the thickness is estimated between 5,000 and 6,000 feet.

J. J. Stevenson found the Triassic on Beaver Creek, a few miles northeast of Canon City, 2,700 feet in thickness, and unconformable with the Jurassic above, wherever it is observed in this region.

Prof. G. M. Dawson,† separated the Triassic or Jurassic of the Rocky Mountains, near the boundary monument, in descending order, into—1st. Fawn-colored flaggy beds, 100 feet. 2d. Beds characterized by a predominant red color, and chiefly red sandstone, but including some thin greyish beds, and magnesian sandstones, the whole generally thin bedded, though sometimes rather massive. Ripple marks, etc., weathers to a steep rocky talus, where exposed on the mountain sides ; and passes gradually down into the next series, 300 feet.

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* Geo. Sur. W. 100th Meridian, vol. 3.
† Rep. Geo. 49th Parallel.

Theo. B. Comstock* found the Jurassic limestones outcropping in many places, in the Wind river country, particularly in the neighborhood of the mountains, upon both sides of the plateau, and having a thickness of about 1,000 feet.

And Prof. E. D. Cope† described from the Trias of the Rocky Mountains, in New Mexico, *Typothorax coccinarum.*

In 1876, Prof. J. W. Powell‡ separated the Jurassic and Triassic rocks of the Plateau Province of the west in descending order, as follows—

1.	Flaming Gorge Group, ...	1200 feet.
2.	White Cliff Group, ...	1100 "
3.	Vermilion Cliff Group, ...	1100 "
4.	Shinarump Group, ...	1800 "

The Flaming Gorge Group is of Jurassic age, the other three are situated above the carboniferous, but whether they should be referred to the Jurassic or the Triassic has not been determined.

The Flaming Gorge Group consists of bad-land sandstones, sometimes argillaceous with much gypsum, massive sandstones and limestones. A bed of limestone at the base is from 10 to 200 feet in thickness. In Southern Utah it caps an extensive escarpment which is called the white cliff limestone. It can be well studied at Flaming Gorge, the type locality. Commencing at the conglomerate of the Henry's Fork Group, and going southward, you pass over the upturned edges of the beds, crossing the bad-land sandstones, then the mid-group limestones, and then the bad-land indurated sandstones until the limestone is reached. The bad-land sandstones both above and below the mid group limestone are of fresh water origin.

The White Cliff Group is a massive, obliquely laminated sandstone, often a beautiful white or golden color, sometimes red. In a few places there are heavily bedded sandstones. The typical locality is in Southern Utah. The Paria, Kanab, and Rio Virgen with their many tributaries that head in the Pink Cliffs above and to the north, have cut many canons and canon valleys through these escarpments plainly revealing the structural geology and stratigraphy.

The Vermilion Cliff Group consists of massive sandstones with ferruginous layers, and often with thin, irregular beds of cherty limestone ; the massive beds sometimes broken into thinner strata. It is also well exposed in the Paria, Kanab, Rio Virgen and their tributa-

* Jones' Report on Northwestern Wyoming, etc.
† Proc. Acad. Nat. Sci.
‡ Geo. of Uinta Mountains.

ries. The wagon road from Toquerville to Paria, a little town on the Paria river, soon after climbing the Hurricane Ledge, reaches the foot of the Vermilion Cliffs, and continues at this geological horizon until it commences to descend into the valley of the Paria. For seventy-five miles the road lies under this great ledge, whose salient buttes, deep alcoves, terraced and buttressed walls, towering pinnacles, all brightly colored in orange, vermilion and purple, and dotted here and there with straggling cedars and nut pines, constitute a grand panorama to the passing traveler. Flaming Gorge, on Green river, is cut through beds of this group, and received its name from the bright colors of the sandstone. Labyrinth Canon and Glen Canon present fine exposures, and fine exposures may also be seen along the Colorado Chiquito.

The Shinarump Group is separable into the Upper Shinarump consisting of bad-land sandstones with much gypsum; often argillaceous; sometimes indurated sandstones. 2d the Shinarump conglomerate, consisting of a fine conglomerate, not easily recognized toward the north, about 20 feet in thickness, but increasing southward until it attains 200 feet. It is found capping an extensive escarpment, known as the Shinarump Cliffs. And 3d, the Lower Shinarump, consisting of bad-land sandstones with much gypsum; sometimes argillaceous; in a few places they are indurated sandstones; sometimes unconformable by erosion with the next. In such places a conglomerate is found at the base, composed of rounded and angular fragments of carboniferous rocks.

The variegated beds above and below the conglomerate are seen in many places on either flank of the Uinta Mountains, and from time to time this horizon is brought up by faults or flexures in all the stretch of country which intervenes between the Shinarump Cliffs and the Uinta Mountains. This group may be seen at the foot of the cliff on the south side of Flaming Gorge, and throughout the valley of Sheep Creek. Outcrops are found in Po Canon district, at the foot of the Yampa plateau to the east, south and west, from the foot of Whirlpool Canon, through the Island Park district, and south of Echo Park, at the foot of the Yampa plateau.

The Shinarump Conglomerate is characterized by the occurrence of silicified wood in large quantities. Sometimes trunks of trees occur, from 50 to 100 feet in length. Shinarump means literally "Shin-auav's Rock." Shinauav is one of the Gods of the Indians of that country, and they believed these trees to have been his arrows.

The plane of demarkation between the Shinarump and the summit of the Carboniferous is always well marked.

Prof. C. A. White described from the Flaming Gorge Group, Green river, near the northern boundary line of Utah, *Unio stewardi*, and from the mouth of Thistle Creek, Spanish Fork Canon, Utah, *Neritina powelli.*

R. P. Whitfield * described from the Jurassic in the Bridger Mountains, Montana, *Gryphaea planoconvexa*, *Gervillia sparsalirata* and *Myalina perplana.*

Dr. F. V. Hayden,† speaking of the Triassic Group of Colorado and the West, as late as 1876, says:

The Red Beds or Triassic Group is very persistent, and if absent at all, only at very short intervals. No organic remains have yet been found in this group, by the members of the survey under my charge, yet, for various reasons, we have assumed the red sandstones to be of Triassic Age. It is barely possible that a portion or all of the Group is of Jurassic Age. Yet Prof. Cope is of the opinion that he has discovered evidence in New Mexico of its Triassic Age. The history of this Group is still obscure, and remains as one of the problems to be solved by more extended and more thorough explorations. Geographically it is one of the most widely distributed formations in the west. From the northern boundary to the southern line and east of the Wasatch range, in Utah, this red formation makes its appearance wherever a mountain range is elevated so as to expose the various sedimentary groups. The evidence indicates that it extends without any important interruption over the broad area as defined above. These red sandstones have always attracted much attention, on account of their peculiar color, but nowhere have I ever observed them performing such a conspicuous part in giving form to the scenery of the country, as along the eastern base of the Rocky Mountains in Colorado. This feature is more marked from a point about fifty miles north of Denver to Colorado Springs, than in any other portion of the continent. Along this belt the sandstones are more compact, with every variety of red, from a pale, dull tint to a deep purple color. There is also every variety of texture, from a rather coarse conglomerate to a fine sandstone. It varies much in thickness, ranging from 400 to 2,000 feet. These sandstones in Pleasant Park, the "Garden of the Gods," and other places have been weathered into the most fantastic shapes, and stand up in immense walls or columns from 50 to 250 feet in height.

Dr. A. C. Peale found Permian fossils in the beds below the red sandstones referred to the Triassic, and as Dr. Hayden and others had

* Carroll to Yellow Stone, Nat. Park.

† U. S. Geo. Sur. Terr.

found Jurassic fossils, in the beds above, which are referred to Jurassic age, it left the conclusion with him that the red sandstones are of Triassic age. The credit, however, of first announcing the age of these sandstones is due to M. Jules Marcou, who, as early as 1853, in his "geological map," etc., "with an explanatory text," referred the beds of conglomerate, described by Capt. Stansbury, in the environs of the Devil's Gate, Rocky Mountains, and the conglomerate and sandstone described by Prof. Dana, on the Shaste river, and the boundary between Oregon and California, to the Trias. The reader may also be referred to his "Resume and Field Notes," in Vol. 3, Pacific R. R. Survey, where he identified these rocks at numerous places near the 35th parallel.

Dr. Peale found a section of Jurassic rocks, at the head of Second Canon, Eagle river, about 940 feet in thickness, and consisting of marls, sandstones and limestones. Another on Roaring Fork below station No. 14, 440 feet thick, and another in the lower Canon of Gunnison river, near station 60, representing 242 feet in thickness. It occurs usually only as a narrow belt outcropping beneath the Dakota Group.

In 1877, Arnold Hague* estimated the thickness of the Triassic on the outlying ridges and foot hills of the east side of the Colorado Range at 800 feet. The group is found immediately overlying the Coal Measures all along the foot-hills of the range, the continuity of the out crop being broken in only a few places, and in most cases, simply by being concealed below the uncomformable Tertiary beds. The rocks are characterized by a prevailing brilliant red color, which shades off into yellowish and whitish tints, and, near the top and bottom of the series, show frequently reddish-gray bands. The deep brick-red color, however, is so persistent as to form one of the most clearly-defined geological horizons of the uplifted sedimentary beds.

The group reaches its greatest development to the southward in Colorado, between the Big Thompson and Cache la Poudre, while north of the railroad it appears much thinner, and, between Lodge Pole and Horse Creek, reaches its minimum. Still farther to the northward, in the region of the Chugwater, it again thickens, but scarcely attains the thickness in Colorado. A section at Chugwater shows between 500 and 600 feet of strata, and another at Box Elder Creek, 650 feet. Sandstones form by far the greater part of the entire series of strata. Even the conglomerates, shales, clays and earthy beds, which occur in-

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* Geo. Expl. 40th Parallel.

terstratified, appear more or less arenaceous, and are really closely allied to true sandstones, only showing considerable diversity in texture and mechanical conditions. Deposits of gypsum are very common in the upper beds.

The Triassic is exposed along the Laramie river, exhibiting a series of nearly horizontal strata, 1,000 feet in thickness. In one place a deposit of pure solid gypsum, 22 feet in thickness, occurs, lying between two beds of hard red sandstone. In the North Park the thickness is estimated at 1000 feet.

S. F. Emmons * found the Triassic in the vicinity of Rawling's Peak, 600 feet in thickness. And in the Uinta Mountains, from 3,700 to 4,000 feet. At its base is a series of clayey beds, having a thickness of 1,200 to 1,500 feet, about equally divided by a thin but persistent bed of limestone. This is succeeded by the Red Bed Group in a thickness of about 2,500 feet, principally of sandstones.

In Henry's Fork Basin, which is a narrow valley, extending 15 miles in either direction, east and west from Green river, with a width of about 3 miles, and whose average level is about 300 feet below the center of the Bridger Basin proper, the Triassic sandstones in Flaming Gorge Ridge, near Green river, are exposed in perpendicular cliffs, about 1,200 feet in height, while having at their base an undetermined thickness of clay beds.

In Emigration, Parley and Weber Canons, in Utah, the Triassic is exposed from 800 to 1,000 feet in thickness. The Jurassic is also present, and in some places has an estimated thickness of 1,500 to 1,800 feet.

The Triassic, in the Desatoya and New Pass Mountains of Nevada, contains highly fossiliferous calcareous shales and limestones. In the Pah-Ute Range in the region of Dun Glen Pass, fossils indicating Jurassic and Triassic ages are found associated together.

The Triassic is represented in the West Humboldt Range, Nevada, in Cottonwood, Buena Vista, Coyote, Bloody and Star Canons. Single sections expose strata 1,500 feet or more in thickness.

Arnold Hague* estimated the thickness of the Jurassic on the outlying ridges and foot hills of the Colorado range at 250 feet, down to 50 feet and less. The rocks consist of loose friable sandstones, limestones, marls, and impure clays, presenting great variety in color and texture, and passing from one to the other by almost imperceptible

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* Geo. Sur. 40th Parallel.

grades. The line separating this group from the Triassic is not clearly defined, and the separation therefore is somewhat arbitrary.

The group attains its greatest thickness in the region of Big Thompson Creek, in Colorado. In Wyoming, along Lodge Pole and Horse Creeks, it is represented by only about 75 feet of strata. Still farther to the northward it expands again to a thickness of 150 feet. On the Laramie Plains west of Antelope Creek the thickness is estimated at 200 feet. On Como Ridge, in the extreme northwestern corner of the Laramie Plains, just west of the 106th Meridian, the Jurassic rocks exhibit all the characteristic strata that have been observed in other localities, associated with organic remains, and possessing a thickness of from 175 to 200 feet. Its thickness in the North Park is estimated at from 200 to 250 feet.

S. F. Emmons* estimated the average thickness of the Jurassic in the Uinta Mountain Region at from 600 to 800 feet, in which the limestones are highly fossiliferous, and have a thickness of 200 or 300 feet, the remainder being made up of sandstones, shales and clay beds, remarkable, where well exposed, for their bright, variegated colors.

In Henry's Fork Basin, a thickness of 300 to 400 feet is observed in the cliffs overlooking Sheep Creek.

In the Montezuma Range, Nevada, the shales have a thickness of between 3,000 and 4,000 feet, and rest directly upon granite. North of Indian Pass, and at Antelope Peak, they reach a development of 4,000 feet.

F. B. Meek† described, from the Triassic at Buena Vista Canon, Nevada, *Sphæra whitneyi*, *Modiomorpha ovata*, *Modiomorpha lata*, *Gymnotoceras rotelliforme*, *Arcestes perplanus*, *A. gabbi*, *Acrochordiceras hyatti*, *Entomoceras laubei*, *Eudiscoceras gabbi*. Hall and Whitfield, from the Trias of Pah-Ute Range, Nevada, *Spirifera alia*, *Edmondia myrina*.

Prof. E. D. Cope,‡ from the Trias at Phoenixville, Pa., *Palaeoctonus appalachianus*, a gigantic carnivorous dinosaurian, *P. aulacodus*, now *Suchoprion aulacodus*, *Clepsysaurus veatleianus*, *Suchoprion cyphodon*, *Thecodontosaurus gibbidens*,§ and *Palaeosaurus frazeranus*, from Texas, *Eryops megacephalus*; and from Painted Canon, in Southeastern Utah,‖ *Dystrophaeus viæmalæ*.

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* Geo. Sur. 40th Parallel.

† U. S. Geo. Expl., 40th Parallel, vol. 4.

‡ Pal. Bull., No. 26.

§ Proc. Am. Phil. Soc.

‖ Wheeler's Sur. W. 100th Mer., vol 4.

Prof. C. A. White,* from the Jurassic south of Dirty Devil river, Utah, *Ostrea strigilecula;* from the North Fork of Virgin river, *Inoceramus crassalatus;* and from Camp Cottonwood, Old Mormon Road, Nevada, *Myophoria ambilineata.*

F. B. Meek,† from the Jurassic at New Pass, Desatoya Mountains, Nevada, *Lima erecta;* from the Weber Canon, Wasatch Range, *Pinna kingi, Cucullæa haguei, Myacites inconspicuus, Myacites weberensis,* and from Cottonwood Canon, *Belemnites nevadaensis.* Hall and Whitfield, from the Jurassic at Flaming Gorge, Uinta Range, Utah, *Rhynchonella myrina, Lima occidentalis,* from Chalk Creek, *Astarte arenosa,* from Shoshone Springs, Augusta Mountains, Nevada, *Terebratula angusta, Aviculopecten augustensis, Septocardia typica, S. carditoidea,* from Wyoming *Natica lelia, Camptonectes pertenuistriatus, Trigonia quadrangularis.*

Prof. E. D. Cope first suggested that the rocks at Canyon City, Colorado, supposed by Prof. Hayden to belong to the Dakota Group (and also those in the same horizon, 100 miles north, supposed by Prof. Marsh to be lower Cretaceous), are Jurassic, and described‡ *Camarasaurus supremus, Compsemys plicatulus,*§ *Caulodon diversidens, Tichosteus lucasanus, Amphicœlias altus,*‖ *A. latus, Symphyrophus musculosus,*¶ *Caulodon leptogamus, Lælaps trihedrodon.***

And Prof. O. C. Marsh†† described, from the Upper Jurassic rocks on the eastern flank of the Rocky Mountains, *Stegosaurus armatus, Atlantosaurus montanus, Apatosaurus ajax, A. grandis, Allosaurus fragilis, Nanosaurus rex.*

In 1878, J. F. Whiteaves‡‡ pointed out the Jurassic Age of certain rocks exposed on Iltasyouco river, in British Columbia, and described *Pinna subcancellata, Grammatodon iltasyoucoensis* and *Trigonia dawsoni.*

Prof. E. D. Cope, from near Canyon City, Colorado,§§ *Hypsirophus discurus, Brachyrophus altarkansanus, Amphicotylus lucasi, Tichosteus æquifacies,* and *Ephanterias amplexus.*‖‖

Prof. O. C. Marsh¶¶ described, from the Upper Jurassic of Colorado, *Atlantosaurus immanis, Morosaurus impar, Allosaurus lucaris,*

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* Wheeler's Sur. W. 100th Mer., vol. 4.

† U. S. Geo. Expl. 40th Parallel.

‡ Pal. Bul., No. 25. § *Ibid.*, No. 26. ‖ *Ibid.*, No. 27. ¶ *Ibid.*, No. 28.

** Bull. U. S. Geo. Sur. Terr., No. 3.

†† Am. Jour. Sci & Arts, 3d ser., vol. 14.

‡‡ Geo. Sur. Can.

§§ Bull U. S. Geo. Sur., vol. 4. No. 1. ‖‖ Am. Nat., vol. 13.

¶¶ Am. Jour. Sci. & Arts, 3d ser., vol. 15 and 16.

Creosaurus atrox, *Laosaurus celer*, *L. gracilis*, *Dryolestes priscus*, *Pterodactylus montanus*.

In 1879, Geo. M. Dawson* found on Nicola Lake, in British Columbia, a great formation built up almost exclusively of volcanic products, which have frequently a characteristically green color, and hold toward the base beds of gray, subcrystalline limestone, intermingled in some places with volcanic material, and holding occasional beds of water-rounded detritus, which he regarded as of Triassic Age.

Dr. C. A. White described,† from the Jurassic of southeastern Idaho, *Terebratula semisimplex*, *Aviculopecten pealei*, *A. altus*, *Meekoceras aplanatum*, *M. gracilitatis*, *M. mushbachanum*, and *Arcestes cirratus*.

Prof. O. C. Marsh‡ described, from the Jurassic of the Rocky Mountains, *Stylacodon gracilis*, *Ctenacodon serratus*, *Dryolestes arcuatus*, *Tinodon robustus*, *T. lepidus*, *Brontosaurus excelsus*, *camptonotus amplus*, *C. dispar*, *Cœlurus fragilis*, *and Stegosaurus ungulatus*.

And Prof. E. D. Cope§ described, from the Jurassic of Colorado, *Camarasaurus leptodirus* and *Hypsirhopus seeleyanus*.

Jurassic strata were determined at Cook's Inlet, in Alaska, as early as 1848, and Grewingk described,‖ from this place, *Ammonites wosnessenski*, and identified *A. biplex*, *Belemnitella paxillosa*, and *Unio liasinus*. And in 1857, Jurassic strata were determined at Point Wilkie on Prince Patrick Land, far north of British America. It was from this place that Capt. McClintock collected the fossils described by Prof. Haughton¶ as *Ammonites macclintocki* and *Monotis* (*Avicula*) *septentrionalis*.

In taking a general view of the Triassic and Jurassic strata, we see them in the eastern part of the continent consisting of narrow belts, having an immense thickness. The thickness in the Connecticut Valley is but little short of four miles, while in New Jersey it exceeds five miles. Israel C. Russell has argued that the physical history of these beds, in New Jersey and Connecticut, tends strongly to show that the two areas are the borders of one great estuary deposit, the central portion of which was slowly upheaved, and then removed by denudation. That the trap sheets were derived from a reservoir beneath the estuary deposits, and represent in part the force that caused the upheaval. The outburst of trap must have been the closing event of the Triassic changes, and have occurred after the sedimentary beds had been up-

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* Geo. Sur. Can.

† Bull. U. S. Sur., Vol. 5, No. 1.

‡ Am. Jour. Sci. & Arts, 3d ser., vol. 18.

§ Am. Nat., vol. 13.

‖ Verhandlungen der Russisch-Kaiserlichen mineralogischen Gesellschaft zu St. Petersbourg.

¶ Jour. Roy. Dub. Soc., Ireland.

heaved and eroded. And that the detached areas, even to North Carolina, must have been part of the same estuary formation, now broken up and separated through the agency of upheaval and denudation.

Much denudation has evidently taken place, which must be added to the enormous thickness which still exists to ascertain the original dimensions of the deposit. All this points to a great depth of the sea, or the bays, as the case may have been, in which the deposits were made.

But when we turn to the Triassic and the Jurassic of the West, we observe them extending from Mexico far into British Columbia, and covering hundreds of thousands of square miles. Over extended areas the Triassic is more than a mile in thickness, and superimposed upon it is a great thickness of the Jurassic ; and again the Jurassic is found more than a mile in thickness resting upon the heavy-bedded Triassic strata. The maximum thickness, therefore, of these formations over great tracts of country is more than two miles, and the questions very naturally arise, what age do they represent ? Could the deposits have been rapidly made, and therefore represent only a brief space of time, or were they extremely slow and indicative of the lapse of millions of years? Were the deposits made in shallow water, or in the depths of mid-ocean? Is there a deposit now taking place that bears any resemblance to these, and if so, what light if any does it throw upon the subject? And what does palæontology, the criterion by which all rocks are to be judged, offer to enlighten us in regard to the secrets of this vast accumulation of detrital material?

All deep-sea dredgings have shown, that at great depths in the Atlantic and Pacific Oceans, there is a deposit of red mud constantly taking place. We think it bears some resemblance to the red sandstone of the Triassic and Jurassic periods, and in order that a comparison may the more readily be made, we quote from the most successful of the many exploring and deep-sea dredging expeditions.

Sir C. Wyville Thomson says,* speaking of the first time that the dredge brought up the mud from the bottom of the Atlantic at the depth of 3,600 fathoms:

"This haul interested us greatly. It was the deepest by several hundred fathoms which had yet been taken, and, at all events coincidently with this great increase in depth, the material of the bottom was totally different from what we had been in the habit of meeting with in the depths of the Atlantic. For a few soundings past, the ooze had been assuming a darker tint, and showed on analysis a continually lessening

* Voyage of the Challenger, vol. 1, 1878.

amount of calcareous matter, and, under the microscope, a smaller number of foraminifera. Now calcareous shells of foraminifera were entirely wanting, and the only organisms which could be detected, after washing over and sifting the whole of the mud with the greatest care, were three or four tests of foraminifera of the cristellarian series, made up apparently of particles of the same red mud. The shells and spines of surface animals were almost entirely wanting; and this is the more remarkable, as the clay-mud was excessively fine, remaining for days suspended in the water, looking in color and consistence exactly like chocolate, indicating therefore an almost total absence of movement in the water of the sea where it is being deposited. When at length it settles, it forms a perfectly smooth red-brown paste, without the least feeling of grittiness between the fingers, as if it had been levigated with extreme care for a process in some refined art. On analysis it is almost pure clay, a silicate of alumina and the sesquioxide of iron, with a small quantity of manganese."

After a great deal of experience in sea dredging, he says:

"According to our present experience, the globigerina ooze is limited in the open oceans—such as the Atlantic, the Southern sea, and the Pacific—to water of a certain depth, the extreme limit of the pure characteristic formation being placed at a depth of somewhere about 2,250 fathoms.

"Crossing from these shallower regions occupied by the ooze into deeper soundings, we find universally that the calcareous formation gradually passes into, and is finally replaced by an extremely fine pure clay, which occupies, speaking generally, all depths below 2,500 fathoms, and consists almost entirely of a silicate of the red oxide of iron and alumina. The clay is often mixed with other inorganic matter, particularly with particles, graduating up to the size of large nodules, of peroxide of manganese; and in volcanic regions, or in their neighborhood, with fragments of pumice. The transition is very slow, and extends over several hundred fathoms of increasing depth; the shells gradually lose their sharpness of outline, assume a kind of 'rotten' look and a brownish color, and become more and more mixed with a fine amorphous red-brown powder, which increases steadily in proportion until the lime has almost entirely disappeared. This brown matter is in the finest possible state of subdivision, so fine that when, after sifting it to separate any organisms it might contain, we put it into jars to settle it remained for days in suspension.

"We recognize the gray ooze as, in most cases, an intermediate stage between the globigerina ooze and the red clay; we find that on one

side, as it were, of an ideal line, the red clay contains more and more of the material of the calcareous ooze, while on the other the ooze is mixed with an increasing proportion of red clay.

"From Teneriffe to Sombrero, the depth goes on increasing to a distance of 1,150 miles from Teneriffe, when it reaches 3,150 fathoms; there the clay is pure and smooth, and contains scarcely a trace of lime. From this great depth the bottom gradually rises; and with decreasing depth the gray color and the calcareous composition of the ooze return. Three soundings in 2,050, 1,900, and 1,950 fathoms, on the 'Dolphin Rise,' gave highly characteristic examples of the *globigerina* formation. Passing from the middle plateau of the Atlantic into the western trough, with depths a little over 3,000 fathoms, the red clay returned in all its purity; and our last sounding, in 1,420 fathoms, before reaching Sombrero, restored the globigerina ooze with its peculiar associated fauna.

"The distance from Teneriffe to Sombrero is about 2,700 miles. Proceeding from east to west, we have about 80 miles of volcanic mud and sand; 350 miles of globigerina ooze; 1,050 miles of red clay; and 330 miles of globigerina ooze; 850 miles of red clay; and 40 miles of globigerina ooze, giving a total of 1,900 miles of red clay to 720 miles of globigerina ooze.

"The nature and origin of this vast deposit of clay is a question of the very greatest interest; and although I think there can be no doubt that it is in the main solved, yet some matters of detail are still involved in difficulty. My first impression was, that it might be the most minutely divided material, the ultimate sediment, produced by the disintegration of the land by rivers, and by the action of the sea on exposed coasts, and held in suspension and distributed by ocean currents, and only making itself manifest in places unoccupied by the globigerina ooze. Several circumstances seemed, however, to negative this mode of origin. The formation seemed too uniform; whenever we met with it, it had the same character, and it only varied in composition in containing less or more carbonate of lime.

"Again, we were gradually becoming more and more convinced that all the important elements of the globigerina ooze lived on the surface; and it seemed evident that, so long as the conditions on the surface remained the same, no alteration of contour at the bottom could possibly prevent its accumulation; and the surface conditions in the Mid-Atlantic were very uniform, a moderate surface current of a very equal temperature passing continuously over elevations and depressions, and everywhere yielding to the tow-net the ooze-forming foraminifera

in the same proportion. The Mid-Atlantic swarms with pelagic mollusca; and in moderate depths, the shells of these are constantly mixed with the globigerina ooze, sometimes in number sufficient to make up a considerable portion of its bulk. It is clear that these shells must fall in equal numbers upon the red clay; but scarcely a trace of one of them is ever brought up by the dredge on the red clay area. It might be possible to explain the absence of shell-secreting animals *living on the bottom* by the supposition that the nature of the deposit was injurious to them; but the idea of a current sufficiently strong to sweep them away, if falling from the surface, is negatived by the extreme fineness of the sediment which is being laid down. The absence of surface shells appears to be intelligible only on the supposition that they are in some way removed by chemical action.

"We conclude, therefore, that the red clay is not an additional substance introduced from without, and occupying certain depressed regions on account of some law regulating its deposition; but that it is produced by the removal, by some means or other, over these areas, of the carbonate of lime, which forms probably about 98 per cent. of the material of the globigerina ooze. We can trace, indeed, every successive stage in the removal of the carbonate of lime, in descending the slope of the ridge or plateau where the globigerina ooze is forming, to the region of the clay; we find, first, that the shells of pteropods and other mollusca, which are constantly falling on the bottom, are absent; or, if a few remain, they are brittle and yellow, and evidently decaying rapidly. These shells of mollusca decompose more easily, and disappear sooner than the smaller, and apparently more delicate shells of rhizopods. The smaller foraminifera now give way, and are found in lessening proportion to the larger; the coccoliths first lose their thin outer border and then disappear; and the clubs of the rhabdoliths get worn out of shape, and are last seen, under a high power, as minute cylinders scattered over the field. The larger foraminifera are attacked, and instead of being vividly white and delicately sculptured, they become brown and worn, and finally they break up, each according to its fashion: the chamber-walls of *Globigerina* fall into wedge-shaped pieces, which quickly disappear; and a thick rough crust breaks away from the surface of *Orbulina*, leaving a thin inner sphere, at first beautifully transparent, but soon becoming opaque and crumbling away.

"In the mean time, the proportion of the amorphous, red clay to the calcareous elements of all kinds increases, until the latter disappear, with the exception of a few scattered shells of the larger foraminifera,

which are still found, even in the most characteristic samples of the red clay.

"There seems to be no room left for doubt that the red clay is essentially the insoluble residue, the ash, as it were, of the calcareous organisms which form the globigerina ooze after the calcareous matter has been by some means removed. An ordinary mixture of calcareous foraminifera with the shells of pteropods, forming a fair sample of globigerina ooze from near St. Thomas, was carefully washed, and subjected, by Mr. Buchanan, to the action of weak acid; and he found that there remained, after the carbonate of lime had been removed, about one per cent. of a reddish mud, consisting of silica, alumina, and the red oxide of iron. This experiment has been frequently repeated with different samples of globigerina ooze, and always with the result that a small proportion of a red sediment remains, which possesses all the characters of the red clay. I do not for a moment contend that the material of the red clay exists in the form of the silicate of alumina and the peroxide of iron in the shells of living foraminifera and pteropods, or in the hard parts of animals of other classes. That certain inorganic salts other than the salts of lime exist in all animal tissues, soft and hard, in a certain proportion, is undoubted; and I hazard the speculation that during the decomposition of these tissues in contact with sea water and the sundry matters which it holds in solution and suspension, these salts may pass into the more stable compound of which the red clay is composed.

"Shortly after the red clay has assumed its most characteristic form, by the total removal of the calcareous shells of the foraminifera, at a depth of say 3,000 fathoms, the deposit in the Pacific Ocean in many cases begins gradually to alter again, by the increasing proportion of the shells of Radiolarians, until, at such extreme depths as 4,575 fathoms, it has once more assumed the character of an almost purely organic formation—the shells of which it is chiefly composed being, however, in this case siliceous, while in the former they were calcareous. The radiolarian ooze, although consisting in great part of the tests of Radiolarians, contains even in its purest condition a very considerable proportion of red clay. While foraminifera are apparently confined to a comparatively superficial belt, Radiolarians exist at all depths in the water of the ocean.

"The distribution over the bed of the ocean may be broadly defined thus: the globigerina ooze covers the ridges and the elevated plateaus, and occupies a belt at depths down to 2,000 fathoms round the shores, outside the belt of shore deposits; and the red clay covers the floor of

the deep depressions, the eastern, the northwestern, and the southwestern basins. An intermediate band of gray ooze occurs in the Atlantic at depths averaging perhaps from 2,100 to 2,300 fathoms.

"Over the red-clay area, as might have been expected from the mode of formation of the red clay, the pieces of pumice and the recognizable mineral fragments were found in greater abundance; for there deposition takes place much more slowly, and foreign bodies are less readily overwhelmed and masked; so abundant are such fragments in some places, that the fine amorphous matter, which may be regarded as the ultimate and universal basis of the deposit, appears to be present only in small proportion.

"The clay which covers, broadly speaking, the bottom of the sea at depths greater than 2,000 fathoms, Mr. Murray considers to be produced, as we know most other clays to be, by the decomposition of feldspathic minerals; and I now believe that he is in the main right. I can not, however, doubt that were pumice and other volcanic products entirely absent, there would still be an impalpable rain over the ocean-floor of the mineral matter, which we know must be set free, and must enter into more stable combinations, through the decomposition of the multitudes of organized beings which swarm in the successive layers of the sea; and I am still inclined to refer to this source a great part of the molecular matter which always forms a considerable part of a red-clay microscopic preparation."

It is quite clear, that it would require millions of years for an accumulation to take place two miles in thickness, at the progress now in operation in the Atlantic, at depths from three to five miles. And one can not help thinking that such deposits bear strong resemblance to the red sandstones of the Jurassic and Triassic strata, and concluding, unless there is some reason to be drawn from other sources, to infer a more rapid deposition in the formation of the latter strata than that which prevails at the present time, that one is the representative of the other as to the depth of the ocean and the material and method of the deposit. If this be so, the Triassic and Jurassic rocks represent an age of vastly greater duration than the combined Cretaceous, Tertiary and Post-pliocene periods.

Palæontology may not follow such a comparison all the way to the final conclusion, but it walks hand in hand so far that we are at a loss to imagine where the separation may be made. There are many classes and orders of animals that never find a tomb in the great depths of the Atlantic, there are others that start for that goal but reach it only in the shape of an impalpable powder, "the insoluble

residue, the *ash* as it were of the calcareous organisms." And as to the rest they are sparsely distributed. In this respect the comparison with the Triassic and Jurassic is most favorable, as the rarity of fossils in the hands of the collectors very clearly testifies.

But when we examine the fossils that have been discovered, and note the evolution of forms, and compare these with the progress in other ages, we are most profoundly impressed with the immense lapse of time that must be ascribed to these periods. As not a single species that is found in rocks earlier than the Triassic, and not one that is found in rocks more recent than the Jurassic, has ever been found in either the Triassic or Jurassic strata, we are sent at once to the genera for comparison. Let us first turn to the Vegetable Kingdom.

It is represented in the Triassic and Jurassic of North America by 66 described species, distributed among 30 genera. Twelve of these genera are also of palæozoic age, viz.: *Calamites*, *Chondrites*, *Cyclopteris*, *Dadoxylon*, *Fucoides*, *Neuropteris*, *Noeggerathia*, *Odontopteris*, *Pecopteris*, *Sphenopteris*, *Tæniopteris*, and *Walchia;* and seven genera are found in the Cretaceous, or more recent strata, viz.: *Chondrites*, *Equisetum*, *Neuropteris*, *Pecopteris*, *Pterophyllum*, *Sphenopteris* and *Tæniopteris*. This shows that five genera only, or one sixth of all that are known, passed through this period, and that during this period 16 genera, or more than half of what are known, came into existence, and also became extinct. The change of forms, as thus indicated, is greater than that which has occurred to the Cretaceous flora during all the ages that have elapsed to the present time.

The evidence furnished by the invertebrate kingdom is no less striking.

Thus far no species belonging to the Annelida or Crustacea, has been described from these rocks, and the only articulated animal-found fossil, so far as I have ascertained, is the *Mormolucoides articulatus*, described by Prof. Hitchcock, in 1858,—a genus unknown in other rocks. The class Pteropoda and the Rudista are unknown. The class Polypi is not represented by a described species, and the *Carea prisca* alone represents the Bryozoa—another genus unknown in other rocks.

The Echinodermata is represented by an *Asterias* and a *Pentacrinus*, genera unknown in the Palæozoic age, but one of them passed up into the Cretaceous, and the other into the Tertiary period.

The Brachiopoda are represented by eleven species belonging to the genera *Lingula*, *Rhynchonella*, *Spirifera* and *Terebratula*. All of these are Palæozoic genera, and all of them have continued an exis-

tence to recent times, except *Spirifera*, which, so far as known, terminated its career in the Jurassic age.

The Gasteropoda is represented by nine species belonging to eight genera. Two of these genera, *Dentalium* and *Turbo*, had an existence in the Palæozoic age, and continued to live until the Tertiary period. One genus *Lioplacodes* commenced and terminated during the age in question. The other five genera, *Neritella*, *Neritina*, *Planorbis*, *Valvata* and *Viviparus* are counted among the living Gasteropoda.

The Cephalopoda is represented by thirty species distributed among seven genera. One, the *Nautilus*, is a palæozoic and living genus. Two, *Goniatites* and *Orthoceras*, are palæozoic genera that closed their existence in the Jurassic age. One, *Meekoceras*, is confined to rocks of the age in question. The other three genera, *Ammonites*, *Belemnites* and *Ceratites*, commenced their existence in the age in question, and terminated their career in the Cretaceous period.

The Lamellibranchiata is represented by 125 species distributed among 51 genera. Six genera, *Avicula*, *Cardium*, *Lima*, *Mytilus*, *Ostrea* and *Pinna*, are reckoned among the palæozoic and living. Of the other 45 genera, eleven of them are palæozoic, but only 24 have yet been found in the Cretaceous. 19 of these are Tertiary, and 7 are living, all of which are marine except *Unio*, which is now a fresh-water genus. Or looking at this most numerously represented class of the Invertebrata in another light, we observe that of the 51 genera represented in the rocks in question, 13 genera, or more than 25 per cent., are still living. 21 genera had passed away before the Cretaceous period, leaving 30 genera only in the latter period; and consequently only 17 of these genera have expired since the dawn of the Cretaceous.

The vast changes in the vertebrate kingdom during this period, and the grand passage from the Batrachia to the Mammalia, evidences the same great laspe of time that is indicated by other organic remain, and inferred from the vast thickness and extensive distribution of the strata.

The class Pisces is represented by fifteen species belonging to nine genera. Two of these genera, *Amblypterus* and *Palæoniscus*, are also of Palæozoic age. The other seven are not represented so far as known in rocks of older or younger age.

The class Aves is represented only by *Palæonornis struthionoides*, a bird named by Prof. Emmons, in 1857—a genus, however, not yet clearly defined or understood.

The class Reptilia is represented by 41 genera, none of which are of Palæozoic age, and only two, *Lælaps* and *Pterodactylus*, are said to

reach the Cretaceous era. Where tracks have been described new genera in all instances have been proposed.

The Mammalia are represented in the Triassic rocks by *Dromatherium silvestre*, described by Prof. Emmons, in 1857. Four genera have been named from the Jurassic, viz: *Ctenacodon*, *Dryolestes*, *Stylacodon* and *Tinodon*. These genera are not only confined to the rocks in question, but they are not referred to families found in other rocks.

Or taken as a whole, the vertebrate kingdom is represented by 57 genera, two of which only are referred to rocks of earlier date, and only two to a later period.

These calculations are based upon our present knowledge of the fauna and flora, but as new discoveries are being made almost daily, we can not tell how much they may be modified in future. It will be observed, however, that an increased number of species will not change the calculations, and that an increase of the genera is more likely by adding new ones, than by the discovery of either Palæozoic or Cretaceous genera in these rocks.

Amphicœlias fragillimus was described by Prof. Cope, from near Canyon City, Colorado, in 1878. (See *Am. Nat.* for August.) *Hypsirhopus seeleyanus* should have been referred to the Jurassic of Wyoming, instead of Colorado; and *Palæoctonus appalachianus*, *Suchoprion aulacodus*, *Clepsysaurus veatleianus*, *Suchoprion cyphodon*, *Thecodontosaurus gibbidens*, and *Palæosaurus frazeranus* should have been referred to York County, Pennsylvania, instead of Phoenixville.

We will now pass the Triassic and Jurassic periods for the purpose of considering the Cretaceous or last period that is referred to Mesozoic age.

CRETACEOUS.

The existence of the Cretaceous formation, upon this continent, was first determined in the year 1827, when Dr. S. G. Morton and Lardner Vanuxem* compared the marl of New Jersey with the Cretaceous of Europe, called by the French *la craie inferieure ou ancienne*, and by the English the Green Sand formation or Ferruginous Sand-series.

In 1828, Dr. J. E. DeKay† described, from New Jersey, *Ammonites hippocrepis*, now *Scaphites hippocrepis*, and *A. placenta*, now *Placenticeras placenta*.

[To be Continued.]

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* Am. Jour. Sci. & Arts, vol, 12.
† Ann. Lyc, Nat. Hist., N. Y., vol. 2.

DESCRIPTIONS OF NEW CRINOIDS FROM THE CINCINNATI GROUP OF THE LOWER SILURIAN AND THE SUBCARBONIFEROUS OF KENTUCKY.

By A. G. Wetherby, A. M.,

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Glyptocrinus richardsoni, nov. sp.

Plate XVI., fig. 1, azygos side; 1*a*, portion of ray enlarged, showing fixed pinnulæ.

Under basals—Not developed, or so slightly as not to be characterized.

Basals—Five, pentagonal, wider than high, and so arranged as to alternate with the first radials, the center of which is continuous with their line of junction. In none of the specimens studied are these plates sufficiently well shown to indicate anything in addition to what is here given.

Radials—First series five, pentagonal, somewhat higher than wide, the lower extremity resting between the upper faces of contiguous basals. Each of these plates has a much elevated central portion, of the same general form as the plate itself, from the lower part of which the thinner articulating edges project.

Second series five, hexagonal, higher than wide, and resting squarely upon the upper side of the first radials. These plates, also, have a raised central portion, quadrangular in form, from which the lateral articulating edges project at a much lower level.

Third or axillary series five, hexagonal, higher than wide, and resting upon the upper face of the second series. These plates, also, have the raised central area, which is slightly depressed at the line of junction of the two upper articulating surfaces, giving this extremity a bifurcate appearance at first glance. Upon this series of radials the first division of the rays takes place. The only one of which all subsequent subdivisions are clearly shown, is that figured on the right side of the azygos area. The branches of this ray, after the first bifurcation, take a very different course. The one upon the right divides but once more, and that is about the fiftieth plate above. The left hand branch, or that next to the azygos side, first divides upon the sixth plate above, and each of these branches again upon the fiftieth (?) plate above this. There thus result from the subdivisions of this ray six arms at the free extremity. If this is the arrangement for each of the five rays, the number of free arms is thirty. As in the other

species of this genus the rays are uniform in this respect, it is probable that such is the case here.

Interradials—These are hexagonal, and so arranged that in all the areas except that on the azygos side there is first one plate, then two above this for two or three ranges, after which the plates become smaller, and their arrangement too indefinite to be determined in the specimens studied. The azygos side has first one plate, above this two in the first range, and three in a few succeeding ranges, when the plates become smaller and the arrangement is not clearly shown.

Interaxillaries—These are numerous, hexagonal or pentagonal, and slightly elevated in the center, forming blunt spines or tubercles. Before the arms become free, at the top of the body, they send off a number of jointed processes like large pinnulæ, which are grooved upon the inner side, but soldered together by small plates.

Body—These plates, together with the radial frame work, and the interradial and interaxillary areas, make up the body of the crinoid, which is plainly pentagonal in outline, being rendered so by the conspicuous ridges formed by the elevated central portion of the radials, and the greater depression of the interradial and interaxillary areas.

The Column—This is round, and much resembles that of the *G. decadactylus*. Several inches of the column attached to one of the specimens, show that the plates become slightly thinner as they approach the body.

Arms—Thirty (30?), composed of nearly equal, slightly cuneiform plates; they are long, taper very gradually, and with the much elongated, slender pinnulæ, give the species a peculiarly graceful appearance.

The Pinnulæ—These are long, slender, ten or twelve jointed, and arise from the inner thickened extremities of alternate plates upon either side of the arms.

The Vault—The mere fragment of the vault preserved shows that it is composed of small irregularly pentagonal or hexagonal pieces.

Remarks—This rare and beautiful crinoid is named in honor of its discoverer, Mr. J. M. Richardson, of Wilmington, Clinton Co., Ohio, who found it in the upper part of the Cincinnati Group at that place. The specimens figured belong to the collection of Dr. L. B. Welch, of Wilmington. These very earnest naturalists have devoted much time to the collection and study of the rare fossils in the region about Wilmington, and have added largely to our knowledge of its palæontological treasures.

It seems proper, in concluding this description, to make some re-

marks that a careful study of the different species of *Glyptocrinus*, found in the Cincinnati Group, has suggested. The species naturally fall into two groups, the extremes being represented by *G. decadactylus* and *G. nealli.* The former group is characterized by a round column, comparatively few interradials and interaxillaries, by the slight depression of these areas, by want of underbasals, and by the greater amount of ornamentation on the plates.

The latter group is characterized by a pentagonal column, many interradials and interaxillaries in deeply sunken areas, by fully developed under basals, and by the comparative want of ornamentation on the plates. Now these two groups are closely united by a series of intermediate forms, of which the *G. richardsoni* is the last and most important link. It agrees with the first group in its round column, want of under basals, and less numerous interradials; and with the second in its depressed areas, numerous interaxillaries, want of ornamentation on the plates, and division of the free arms. As the development of under basals has always been considered to be of generic importance, and as the *G. nealli* for that reason, and the greater number and irregular arrangement of its interradials and interaxillaries, seems to be as closely allied to *Reteocrinus* of Billings, as to *Glyptocrinus*, it is especially interesting to find the intermediate form in the species herewith described. Mention is made in the description of the interaxillary areas, of a series of branches or fixed pinnulæ given off by the rays.

It seems clear that the earliest portion of the crinoid to be developed is the lower part, or that represented by the basal and radial rings of plates and the interradials when present; or rather that here was a center of growth, from which the column grew downward, and the body and its appendages upward. It is not difficult to see that the increase of given functions, due to the progressing maturity of the animal, may have enlarged the number of organs devoted to special uses, and thus the ambulacral grooves, at first continued only along the inner face of the radials, were diverted into auxiliary grooves on the ventral or inner side of the processes mentioned above. As the body grew upward, these branches gradually lost their free character, and became soldered into the general body wall by the interpolation of its plates, while new branches were given off, above these, to take their places, which eventually became fixed in like manner. In this way the conditions of growth were furnished, and the body was gradually built up.

As the animal approached maturity, the plates forming the sides of

the body became smaller; the degree of definiteness in the areas became less; and finally the whole system of plates united, arching over the body cavity, and forming what our collectors have long known as the "stomach" of *Glyptocrinus.* At this time the rays became free arms, and the ambulacral grooves were now carried by them outside the body cavity. These grooves, in the *G. oncalli* at least, were covered in by a series of plates attached to the edges of the arms, between which and the latter, the pinnulæ passed out. These plates become less and less developed from the inner bases of the arms outward, and disappear before reaching the tip of the latter. In the same species both grooves and pinnulæ are continued into the rays beneath the vault or covering of the body. On account of its position as an intermediate link, very great interest attaches to this species, and collectors in its horizon should search diligently for every scrap of evidence concerning it, as well as its not less interesting relative, the *G. fornshelli.*

Cromyocrinus gracilis, nov. sp.

Plate XVI., fig. 2, basal ; *2a*, azygos ; *2b*, opposite side ; *2c*, view of ventral tube ; *2d*, inside view of arm with pinnulæ ; *2e*, inside view of arm without pinnulæ.

Under basals—Five, pentagonal as seen from the outside, lying at the base of the columnar depression, and very rarely exhibited in any of the specimens. They are wider than high, and their apices are on a line with the junction of the first sub-radials.

Basals—Five, three pentagonal, the two on the azygos side hexagonal. The three pentagonal plates are pointed at the upper extremity, which is continuous with the line of junction of the contiguous first radials, the lower sides of which rest upon the upper, sloping faces of these plates.

The two hexagonal sub-radials are made so by the truncation of their angles for the support of the azygos plates. The one on the right has its inner middle angle truncated for the support of the lower end of the lowest right hand plate of the azygos series, as may be seen in the figure. The one on the left, or the adjacent sub-radial on the same side, has its upper central angle truncated for the support of the lower left hand plate of the azygos series. All these plates are convex exteriorly, and so folded in below as to form the columnar depression, at the bottom of which the small basals may be seen. They are without ornamentation.

Radials—First series five, wider than high, pentagonal, all having a broad articulating face above, upon which rest the radials of the

second series, and four of them pointed below, with this extremity embraced by the sub-radials between which they lie. The other plate of this series, which is immediately at the right of the azygos area, is truncated below, and rests upon the upper left lateral face of the adjacent basal. All the plates of this range are slightly convex exteriorly and without ornamentation.

Brachials—Five, irregularly quadrangular, higher than wide, and alike in shape and size. As these plates are slightly narrowed at the upper extremity, and somewhat excavated laterally and centrally, the effect is to constrict this part of the specimens, making the diameter at these plates much less than that at the first radial series.

Azygos plates—Five, the lower one pentagonal, and resting as stated above, on the truncated inner middle angle of the first sub-radial contiguous to it. The others are hexagonal, and upon dissection of the crinoid are shown to be the outer proximal portion of the ventral tube, which, in this species, is made up of hexagonal plates, is round, and tapers gradually upward.

Arms—Five, composed of about fifty nearly equal plates, wider than high, and arranged in single series, as in typical *Graphiocrinus*. The articulating surfaces of the arm plates, as seen from the outside, are nearly parallel. The plates shorten towards the distal extremity of the arms, causing the latter to taper gradually. An inner or lateral view of the arms shows that here the plates are alternately thicker and thinner upon each side, as every other has one extremity thickened and dilated into a process with socket of attachment for the very stout basal joint of the pinnulæ.

Pinnulæ—These are stout, short, few jointed, and taper gradually from the arms outward. They are continued down from the tips of the arms to the last plate, resting upon the brachials, which brings them in immediate connection with the proximal end of the ventral tube.

Remarks—This is one of the rarest crinoids of the Kaskaskia (Chester) Group of the Subcarboniferous, Pulaski county, Kentucky. In the character of single series of arm plates it agrees with *Graphiocrinus*, from which it differs in having but five arms, and a well-defined under basal series. It has also affinities with *Eupachycrinus*, but differs in the character of single arm plates. Its nearest alliance seems to be with *Cromyocrinus*, Trautschold. There are evidences, in one or two specimens, that the arm furrows were covered in by a series of plates, so arranged as to interlock in a zizag manner between the two rows of pinnulæ. While this fact seems to be well shown, it is but the second

case of the kind which I have met up to this time, the other being the *Glyptocrinus nealii* of the Cincinnati Group, Lower Silurian. The specimens illustrated were collected by me at the locality above named, and are a part of my cabinet of subcarboniferous crinoids.

SYNBATHOCRINUS GRANULIFERUS, nov. sp.

Plate XVI., fig. 3, azygos; 3*a*, opposite view.

Basals—Three, pentagonal, wider than high, the upper faces being slightly concave for the reception of the lower convex surfaces of the first radials. They are so approximated centrally as to leave a very small depression, if any, for the reception of the column.

Radials—Five, quadrangular, higher than wide, with the upper and lower articulating surfaces nearly parallel, while the lateral surfaces gradually diverge as these plates widen upwards. They are also thickened at this extremity, and as the proximal ends of the next series are also widened and thickened at the same place, the body of the crinoid at the line of junction of the two radial series has its periphery largely increased.

Brachials—Five, resembling the radials reversed, though scarcely as high, wider below, narrower and thinner above. Upon these plates rest the five arms.

Anals—Two visible, the lower apparently quadrangular or obscurely so, the other quadrangular, and much higher than wide. Nothing further can be determined either in reference to these plates, or the ventral sac of which they are the lower extremity.

Body—This is somewhat pentagonal in outline, very short when compared with the length of the arms, and tapers gradually above and below the junction of the first and second radials.

Arms—Five, slender, tapering very gradually upward, and each composed of about thirty quite regularly quadrangular plates, higher than wide, convex exteriorly, deeply and narrowly grooved by the ambulacral furrows on the inner faces, and showing no evidences of the attachment of pinnulæ.

Column—This is round, and composed of alternately thicker and thinner plates.

Remarks.—The body and arms of this fine species, in the two specimens studied, are ornamented with small, irregularly disposed tubercles or granulations, which are smaller and more thickly studded toward the distal portions of the arms. The specimens described were found by Mr. E. O. Ulrich, in rocks of the age of the Kinderhook

Group of the Subcarboniferous, at King's Mountain Tunnel, on the Cincinnati Southern Railway, and the type was generously given me by him, and belongs to my collection. A fine specimen of the same species is also in Mr. Ulrich's cabinet.

In connection with the publication of new species from the subcarboniferous rocks, and the reference of one of these species to *Cromyocrinus*, Trautschold, it seems necessary to call attention to a paper on the structure of the *Palæocrinoidea*, recently published,* which will be read by all who take an interest in this subject, and which seems to have been the result of a very extended study and intimate knowledge of the genera treated. In the discussion of the genus *Graphiocrinus*, the authors insist upon the generic character of a single "anal" plate. It is a fact well known to careful students of American subcarboniferous crinoids, that several of the species could be referred to this genus by every other character save the number of "anals". Among these is the so-called *Zeacrinus maniformis*, which our authors have placed, provisionally, under a new genus *Scytalocrinus*. While admitting the alliances of this crinoid to *Graphiocrinus*, our authors have not made this reference on account of the number of anal plates. When, however, they come to the discussion of the closely allied genus which was called *Eupachycrinus*, by Meek and Worthen, without any definition, and afterwards, *Cromyocrinus*, by Prof. Trautschold, our authors no longer regard the presence of a definite number of "anals" as necessary, and throw together under *Eupachycrinus* an assemblage of crinoids having the arms in number from five to fourteen, with anomalous numbers like seven and nine, and with single and double rows of arm plates.

In explanation of this reference, it is asserted that this period was one of maximum activity in evolution, and that given characters must be differently interpreted as the result of this fact. It is proposed, briefly, to review this subject, not as a criticism, but to show how these facts appeal to different minds. In the revised descriptions of the genera *Eupachycrinus* and *Graphiocrinus*, by these authors, we have in each, under basals five, basals five, radials five, brachials five. In *Eupachycrinus* "anals generally three, rarely one," in *Graphiocrinus* "a single, rather small anal plate." Trautschold's genus *Cromyocrinus*, as illustrated by his generic figures, and by specimens kindly loaned me by Mr. Wachsmuth, has a greater number of anal plates, which may be formulated as three or more. For comparison, we will now tabulate these formulæ.

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* Revision of the Palæocrinoidea by Chas. Wachsmuth and Frank Springer, Part 1.

Graphiocrinus, Korninck & Le Hon.	Cromyocrinus, Trautschold.	Eupachycrinus, M. & W.
Under basals five.	Under basals five.	Under basals five.
Basals five.	Basals five.	Basals five.
Radials five.	Radials five.	Radials five.
Brachials five.	Brachials five.	Brachials five.
"Anal" one.	"Anals" three or more.	"Anals" three, rarely 1.

The most hasty view of these tables shows that the generic differences, if such exist, must be found in the "anal" plates, or in some portion of the specimens not embraced in the formulæ.

According to figures and descriptions of these genera, and of species referred to them, *Graphiocrinus* has a single row of arm plates, and ten arms. *Cromyocrinus*, single rows of arm plates, and either five or ten arms. *Eupachycrinus*, single or double rows of arm plates, or according to Wachsmuth and Springer, a mixture of these characters in the same specimen, and the arms varying in number, according to examples in my collection, from five to fourteen; specimens having seven and nine arms not being uncommon.

It seems clear that a student of these species will find himself in a state of inextricable confusion, unless this matter shall be adjusted by referring these specimens to a definite place under the different genera as defined. As our authors have made the genus *Graphiocrinus* to include those species of this group with a single "anal" plate, and with ten arms, composed of a single row of arm plates, we may leave this genus out of the discussion, believing that it will include, with the proviso that a single "anal" shall not be held as generic in this case if not in others, a well-defined group of species, of which the *Graphiocrinus encrinoides* is the type.

As regards the genus *Cromyocrinus*, which was correctly defined by its author, it seems well fitted to embrace all those species having three or more "anals," a body composed of comparatively heavy convex plates, and five or ten arms made up of single rows of plates as in *Graphiocrinus*. If the genus *Eupachycrinus* can be regarded as "established," it should be made to include those species of this group having one or more "anals," heavy rounded body-plates, and ten to fourteen arms, with double series of interlocking plates.

It is certainly a curious statement that a character may be generic in one case, and only specific in another, from the same group of crinoids, of precisely the same geological age, surrounded by the same environments, and left as a fossil not only in the same strata but in the same layers.

The so-called "anal plates," as I am satisfied after a very careful study of numerous-sliced specimens, from many distinct genera, were in no case in such relation to the other plates as to be of a valvular

nature, or to represent any excretory or other opening. Indeed, we find authors searching the other extreme of the "ventral sac," of which these plates are simply the lower extremity, and the presence of which they invariably indicate, for such an orifice; and in most cases unsuccessfully. These plates, then, represent no functional character, are but the exposed proximal part of the "ventral sac," and can not have that systematic importance which belongs to radial portions of the crinoids; and they are infinitely less important than characters found in the arms, which are entirely neglected in the groupings of these crinoids made by the writers above mentioned.

But, if the extent to which the parietes of the ventral sac are exposed, by the relations between its proximal portion and the adjacent plates is ever a generic character, *it must always be so*, no matter whether the series of extremes is a long or a short one. In fact, we have no means of testing the amount of differentiation which animals of a given class have undergone in a given time, but by referring this differentiation to generic and specific standards, previously thoroughly well established.

If, then, the presence of one, two, or three azygos plates is to be regarded as a substantiated generic character, and if we find that within a comparatively brief geological epoch, many crinoids have attained this degree of differentiation, we may assume that it has been a period of comparatively rapid evolution; but, on the other hand, if these characters are not well defined, and if a proper study of the specimens indicates the mixed state of affairs, which their discussion of *Eupachycrinus* would lead us to infer, we can only understand that these crinoids ceased to exist, in the midst of a series of changes, always to be observed, when we have an opportunity to investigate the phylogeny of any group of animals. The three genera here discussed form a well-defined group of crinoids, that might, without any violence to a proper systematic arrangement, be placed in a family by themselves. It is even plain that such an arrangement, including, possibly, a few nearly related genera, would be an improvement upon that adopted by our authors, and future studies, from more abundant material, will probably indicate the desirability if not the necessity of such a course.

DESCRIPTION OF TWO NEW SPECIES FROM THE NIAGARA GROUP, AND FIVE FROM THE KEOKUK GROUP.

By S. A. Miller, Esq.

Encrinurus egani, n. sp.

Plate XV., fig. 1, general view of a specimen, having one eye tubercle removed; 1*a*, view of the head with the spines removed; 1*b*, view of the head from the rear, showing the spines.

Corpus—The general form is somewhat elliptical, with the exception of an angular pygidium.

Caput—The cephalic shield has the form, in front, of one end of an ellipse, and the posterior angles terminate in spines, which extend backward about half the length of the thorax. The length from the neck furrow to the front is less than half the width measured at the same furrow. It is bordered by a rim which is very narrow in front, but stronger posteriorly, and in its continuation forms the spines. The rim is ornamented with a row of tubercles. The glabella is clavate and gibbous, projects in front beyond the narrow rim, and contracts between the eyes to less than half its anterior width. It is separated from the cheeks by remarkably deep furrows, and is covered by strong tubercles, which are arranged, in some specimens, in seven to eight transverse rows. There are four tubercles in the posterior row, and as the glabella expands in front, they increase to more than twice this number. The cheeks are narrow, and slope abruptly from the eyes to the marginal furrows. The facial sutures are directed from the eyes forward, so as to reach the margin at the anterior part of the glabella; and from the eyes outward curving backward to the spines at the posterior angles of the cheeks. The occipital furrow is continuous.

The eyes are very large, the bases projecting over part of the occipital furrow, and the furrows separating them from the glabella, and occupying a considerable part of the cheek area. The eye bases are covered by large tubercles. The eyes are pedunculated, and project forward and outward, like two little horns, until the ends are separated by a distance equal to the diameter of the cephalic shield.

Thorax—The thorax has eleven segments. The axis is convex, narrower than each of the lateral lobes, and marked by a row of tubercles upon each side as in *Calymene niagarensis*. The lateral lobes are flattened toward the axis, and bend abruptly downward from the middle toward the outer side. The articulations curve backward and

downward at the bending of the lateral lobes, and were evidently tuberculated at this point. They are strongly grooved.

Pygidium—The pygidium is subtriangular, a little wider than long, and the test evidently terminated in a spine. The axis is depressed convex, has eighteen annulations, and a central row of four tubercles. arranged as follows: commencing at the posterior part, and counting the annulations forward, a tubercle is found upon the 4th, 7th, 11th and 14th annulations. There are six pleuræ on each side directed outward, and gradually curving backward. Each pleura bears a node near the dorsal furrow, and another near the margin.

The species is founded upon casts from the magnesian limestone of the Niagara Group, at Joliet, Illinois. This is the first attempt to describe, from American strata, any fossil in this genus, from anything like complete specimens. Nearly all the species have been founded upon the pygidia alone. None of the species that have been described, however, bear much resemblance to this one, except *Encrinurus ornatus*, and it is very readily distinguished. The annulations, the pleuræ, and the tubercles are more numerous in the *E. ornatus* than they are in this species, and the tubercles do not occupy corresponding annulations in the two species.

The specimens illustrated are from the magnificent collection of W. C. Egan, Esq., of Chicago, Illinois, in whose honor I take great pleasure in proposing the specific name.

CYATHOCRINUS HARRISI, n. sp.

Plate XV., fig. 2, view of the anterior or azygos side, and part of the column, natural size.

Body, cup-shaped, about twice as wide as high, and ornamented by depressions at the corners of the plates, and rounded or subangular ridges between them. Sub radials, hexagonal, except the one on the azygos side which is heptagonal, and a little larger than the others. First radials, wider than high, pentagonal or sub-pentagonal, with the longer side uppermost. The two anterior arms bifurcate on the fourth free arm plate. The facet for the reception of each radial is only about half the breadth of the upper face of the radial. The plates are slightly constricted and rounded in the middle, and much flanged at the upper part, presenting an appearance somewhat similar to a series of small, short spools, piled one upon another, and gradually diminishing in size. Our specimen does not show the second bifurcation of these arms. There is a short, strong pinnule springing from each side of each arm plate above the first bifurcation. Below this, I suppose the

pinnules were only long enough to protect the arm furrows, as none of them are visible.

The first azygos plate is subquadrangular in outline, and about half the size of the adjoining first radials. It supports a series of plates which are flanged at the upper part, and gradually diminish in size while preserving their length, and also by contracting in the middle become more nearly spool-shaped. Six of these, above the first azygos plate, are shown in our specimen.

The column is pentagonal, and for about an inch below the head every fourth plate bears five side arms, one springing from the middle of each side, and below this every eighth plate bears the same number. In the distance of two inches there are twenty-five plates bearing these side arms, or 125 side arms in two inches in length of the column. These side arms consist of cylindrical plates, having a length about equal to one half the diameter, and being perforated in the middle. They are so short that there are 100 plates or more in an inch. Supposing that these side arms of the column were only an inch in length, we would have 12,500 plates in the arms springing from two inches in length of the column. Many of these side arms were thrown across the head, and upon the arms before the specimen was cleaned, and some of them were doubtless more than an inch in length, and I presume from the appearance of the earth around the specimen, that each of them was more than an inch in length.

This species was collected in the Keokuk Group, at Crawfordsville, Indiana, and is from the collection of I. H. Harris, Esq., of Waynesville, Ohio, in whose honor I have proposed the specific name.

There may be some doubt as to whether or not this species properly belongs to Cyathocrinus, as it does not fall within the limits prescribed for that genus by Wachsmuth and Springer, in their recent work on the "Revision of the Palæocrinoidea."

PALÆASTER CRAWFORDSVILLENSIS, n. sp.

Plate XV., Fig. 3, dorsal view, natural size and magnified view of the madreporiform plate.

The species is founded upon the dorsal view of a single specimen. The rays are longer than the diameter of the body, and not of uniform size. They are flattened or depressed in the middle, as is also the central part of the body. Many of the plates possess a central tubercle or small spine, and probably all of them did.

The marginal plates are large, somewhat elliptical in outline, and have their shorter diameters in the direction of the length of the rays.

There are about twelve plates on each side of a ray, and they come together at about the eighth plate from the body, though in the ray opposite the madreporiform tubercle they come together at the seventh. The space between the marginal plates of each ray is filled with smaller plates; three of these unite the larger plates at the body, but they diminish in number toward the apex of the ray, and cease at the eighth plate. In addition to the two large plates which form the junction of the rays with the body, a few large plates cover the outer part while the central part is covered by smaller plates. The madreporiform tubercle is supported by three plates, two of them are large marginal plates, which form a junction between two rays, and the other is a large plate within, forming part of the covering of the body.

Collected at Crawfordsville, Indiana, in the Keokuk Group, and now in the collection of I. H. Harris, Esq., of Waynesville, Ohio.

PLATYCRINUS BLOOMFIELDENSIS, n. sp.

Plate XV., fig. 4, natural size.

Body, large, conical at the base, and pentagonal above, with very slight expansion toward the top. Radial plates, longer than wide, which will distinguish this species from any that have been described from rocks of the same age. The cast is slightly convex at the central part of the radial plates, which may indicate that the exterior part of the plates was tuberculiform at this place.

Collected by W. C. Egan, in the cherty beds of the Keokuk Group at New Bloomfield, Missouri.

CODASTER GRATIOSUS, n. sp.

Plate XV., fig. 5, natural size; 5*a*, summit view.

Body, small, obconoidal, point of attachment to the column minute, length 0.28 inch, diameter 0.20 inch. Basal plates a little more than one third the length of the specimen; two of them are hexagonal, and one pentagonal, counting the minute face which joins the column as a side. The hexagonal plates have a width about equal to their length, the pentagonal plate is longer than wide.

The radials are a little longer than wide, the longitudinal sides are nearly parallel; three of them have each two inferior sides, and two of them have each only one inferior side. The upper margin of each plate is excavated for the reception of the ambulacral structure.

There is no third range of plates in this species, but a small plate adjoining the anal opening, truncates the corners of the two adjacent radials.

The summit is marked by a central ambulacral opening, an anal opening or mouth close to the margin, and ten marginal supports of the interambulacral areas, one being placed upon each side of the ambulacral spaces.

This species is founded upon an exceedingly perfect and unique cast now in my own collection, but which was found by W. C. Egan, of Chicago, Illinois, in the Cherty beds of the Keokuk Group, at New Bloomfield, Missouri. It is the first species described in America, from rocks of the age of the Keokuk Group.

Strotocrinus bloomfieldensis, n. sp.

Plate XV., fig. 6, natural size ; 6*a*, view of the summit of a cast.

Body, large, urn-shaped below, and widely spreading at the arms above. Basal plates, wider than long, and about two thirds the size of the first radials.

First radial plates large, higher than wide, three of them hexagonal, and two of them heptagonal. Second radials, not more than half the size of the first, hexagonal, and about as wide as high. Third radials, heptagonal, about as wide as high, a little smaller than the second radials, and supporting upon their superior sloping sides the secondary radials, from the summit of which spring the plates that form the lower part of the spreading canopy, which is not preserved in our specimens.

The first interradial plate is almost regularly hexagonal, and of the same size as the second radial. It supports upon its superior sloping sides two second interradials, which are a little smaller than the third radials; one of them is pentagonal, and the other hexagonal. These are followed by two third-interradials, which are arranged between the third radials; and these in turn by two fourth interradials, arranged between the secondary radials.

The first azygos plate is heptagonal, resting upon two basal plates, and between two first radials, and surmounted by three plates, it is not to be distinguished in a basal view from the first radials. It is, however, a little smaller than the first radials. Above these, on the azygos side, the outlines of the plates are not preserved in our specimens.

The number of arms can not well be determined, but as there are ten secondary radials, and the cast of the openings connecting with the arm furrows, bifurcate within the length of a small plate from these secondaries, and again and again bifurcate, so that in our illustrated fragmentary specimen, we have five of these branches from a single

secondary radial, and still the broken ends are too large to represent the arm furrows, we may infer that the arms were as numerous as in *Strotocrinus regalis*, which Prof. Hall found to have 72.

A small subcentral proboscis is indicated on top. otherwise the upper surface would appear to be almost flat.

Collected by W. C. Egan, of Chicago, Illinois, in the cherty beds of the Keokuk Group, at New Bloomfield, Missouri.

This species is especially interesting, as being the first of this genus described from the Keokuk Group.

HOLOCYSTITES TURBINATUS, n. sp.

Plate XV., fig. 7, side view; 7*a*, summit view.

Body, somewhat top-shaped or like an inverted conoid. Column, small. Summit, depressed convex, and covered by numerous pits, the economy of which has not been determined. Forty-six of these pits decorate the specimen illustrated. Plates, porous.

The body is covered by six ranges of plates, below the peculiar pits which cover the summit. The second range below the pits is composed of the larger plates, and consists of fifteen. There is irregularity in the form and size of the plates, and also in the number that constitute the several ranges. There is part of a range of plates on the anterior side of the body, immediately above the plates which abut upon the column. This unequal order of arrangement of the plates occurs in all the species of this genus, where the plates of this part of the body have been observed, and is most beautifully shown in the illustration of *H. tumidus.*

This side seems to me to correspond with the azygos side of the crinoids, and if it may be thus compared it effectually disposes of the use of the word "anal" as applied to the azygos plates of the crinoids.

The mouth and ambulacral opening are large in this species, and the anal opening between these orifices minute. The plates are too much anchylosed, and disturbed by the pits, on the summit of our specimen, to permit any determination of their number or shape. The arm bases, too, are not distinct, but there seems to have been four. A small piece of what is supposed to be part of an arm is laying upon the summit.

Collected by C. B. Dyer, in the lower part of the Niagara Group, near Osgood, in Ripley county, Indiana.

NOTE UPON THE HABITS OF SOME FOSSIL ANNELIDS.

By S. A. Miller, Esq.

Collectors of any considerable experience, in the rocks at Cincinnati, have not failed to observe that some of the shells, and many of the corals, are pierced by numerous holes, as if eaten through by some burrowing animal. My attention was attracted to this subject several years ago, and I have spent no small amount of time in endeavoring to solve the mystery, but I had not the slightest conception of the animal that did the work, until last year, when I collected the specimens that enabled me to positively determine the architect. The work done by palæontologists, in Silurian strata, is confined almost exclusively to the morphological characters of the species, and it is rare, indeed, that one is able to determine the habits of the animals themselves. Hence, this discovery may be regarded as of some palæontological importance.

During the past summer and fall I collected a great many corals, preserving within these holes, the small, annulated, conical, flexuous tubes, which were called, by Nicholson, *Ortonia minor*. The specimens show the meandering courses of the little animals through the corals, sometimes cutting the corallites transversely, and at other times longitudinally, and retain within the holes the shells of this species. It is most usual to find the mouth of the shell on or near a level with the polyp cells, but it is found in all other positions in the holes. No doubt can be entertained that this animal bored its way through the coral, and it only remains to determine whether its food was the polyp or the dead calcareous matter. The evidence tends to show that its food was the coral, and not the polyp, but we must delay offering this evidence until another opportunity.

I have elsewhere shown that *Ortonia* is a synonym for *Conchicolites*, and as the habits now ascertained evidently remove this species from the latter genus, and also from the order Tubicola, we must look elsewhere to find a home in which to classify it.

A re-investigation of all the fossils of Silurian strata, which have been referred to the genera *Tentaculites*, *Cornulites* and *Conchicolites*, founded upon additional testimony, must be granted before we shall be able to separate the burrowing from the non-burrowing, or to have any clear ideas of their habits and affinities.

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PLATE XIII.

Fig. 1. ASAPHOIDICHNUS DYERI, n. sp.—View of a specimen, natural size.

Figs. 2 and 3. TRACHOMATICHNUS NUMEROSUS, n. sp.—Casts from the trails of the animal.

Fig. 4. The trail itself as made in the sediment, which is now hardened into a rock.

Fig. 5. TRACHOMATICHNUS PERMULTUS, n. sp.—Cast from the trail of the animal.

PLATE XIV.

Fig. 1. Teratichnus confertus, n. sp.—View of the trail, natural size.

Fig. 2. Petalichnus multipartitus, n. sp.—View of the cast of the trail, natural size.

Fig. 3. Trachomatichnus cincinnatensis, n. sp.—View of the cast of the trail, natural size.

Figs. 4 and 5. Ormathichnus moniliformis, n. sp.—Natural size.

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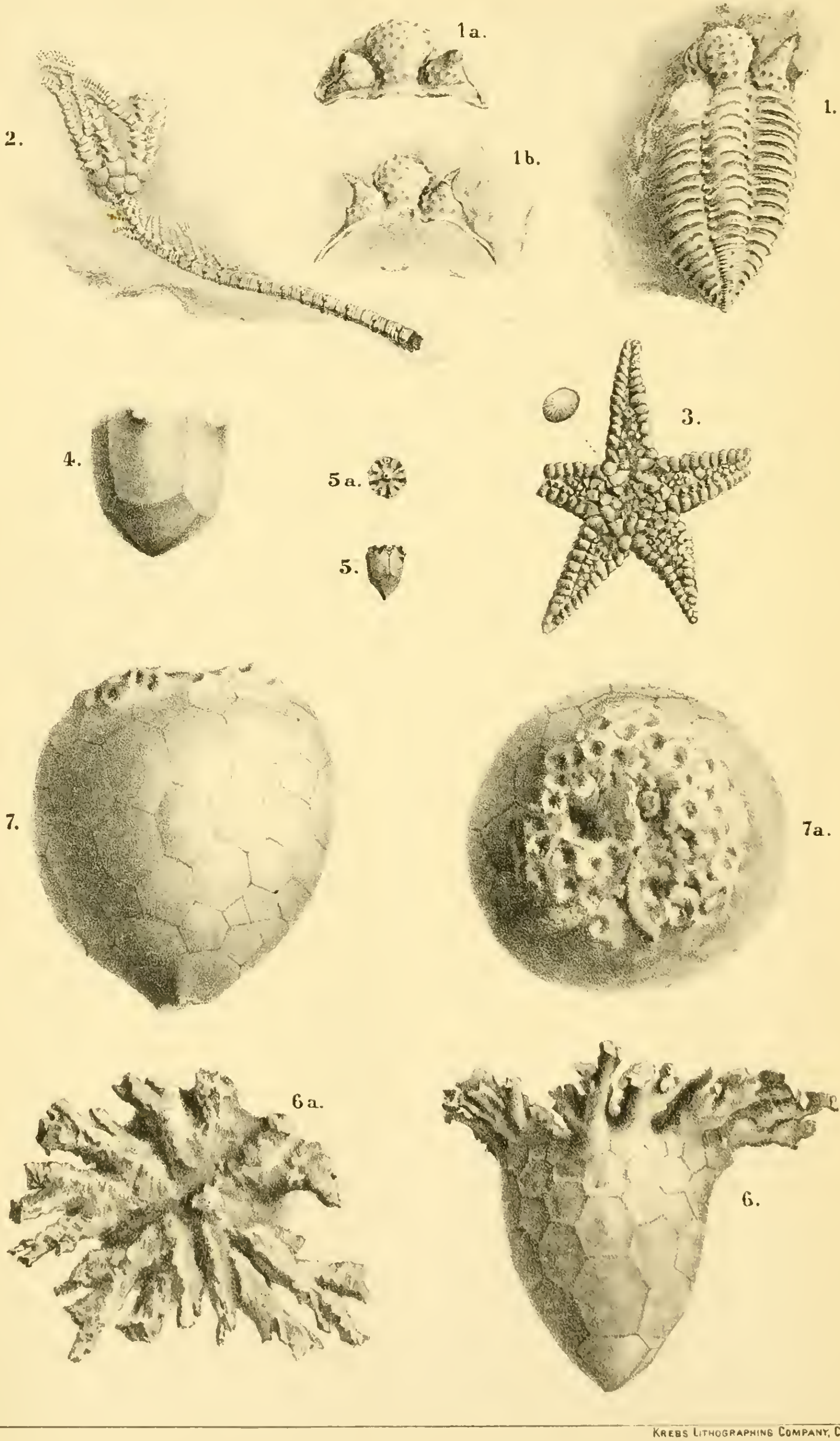

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PLATE XV.

Fig. 1. ENCRINURUS EGANI, n. sp.—General view of a specimen having one eye tubercle removed. (The backward curving of the articulations upon the lateral lobes is not clearly represented, and the annulations on the pygidium are not clearly represented, which apparently throws the tubercles one annulation too far forward).

1*a*. View of the head with the spines removed, and the points of the eye tubercles broken off.

1*b*. View of the head from the rear showing the spines. From Joliet, Illinois.

Fig. 2. CYATHOCRINUS HARRISI, n. sp.—View of the anterior or azygos side and part of the column, natural size. From Crawfordsville, Indiana.

Fig. 3. PALÆASTER CRAWFORDSVILLENSIS, n. sp.—Dorsal view, natural size, and a magnified view of the madreporiform tubercle. From Crawfordsville, Indiana.

Fig. 4. PLATYCRINUS BLOOMFIELDENSIS, n. sp.—Side view of a cast, natural size. From New Bloomfield, Missouri.

Fig. 5. CODASTER GRATIOSUS, n. sp.—Side view, showing the mouth or anal opening.

5*a*. Summit view of the cast. From New Bloomfield, Missouri.

Fig. 6. STROTOCRINUS BLOOMFIELDENSIS, n. sp.—Side view, natural size.

6*a*. View of the summit of the same specimen. From New Bloomfield, Missouri.

Fig. 7. HOLOCYSTITES TURBINATUS, n. sp.—Side view, natural size.

7*a*. View of the summit, with the mouth upon the left side, and the ambulacral opening upon the right, with a piece of a column or extraneous matter in it. Also showing a fragment upon the lower side of what is supposed to be a piece of an arm. From Osgood, Indiana.

PLATE XVI.

Fig. 1. Glyptocrinus richardsoni—Azygos side.

1*a*. Portion of ray of same enlarged, showing fixed pinnulæ. Dr. Welch's collection.

Fig. 2. Cromyocrinus gracilis—Basal view, magnified two diameters.

2*a*. Azygos side, natural size.

2*b*. Opposite side, natural size.

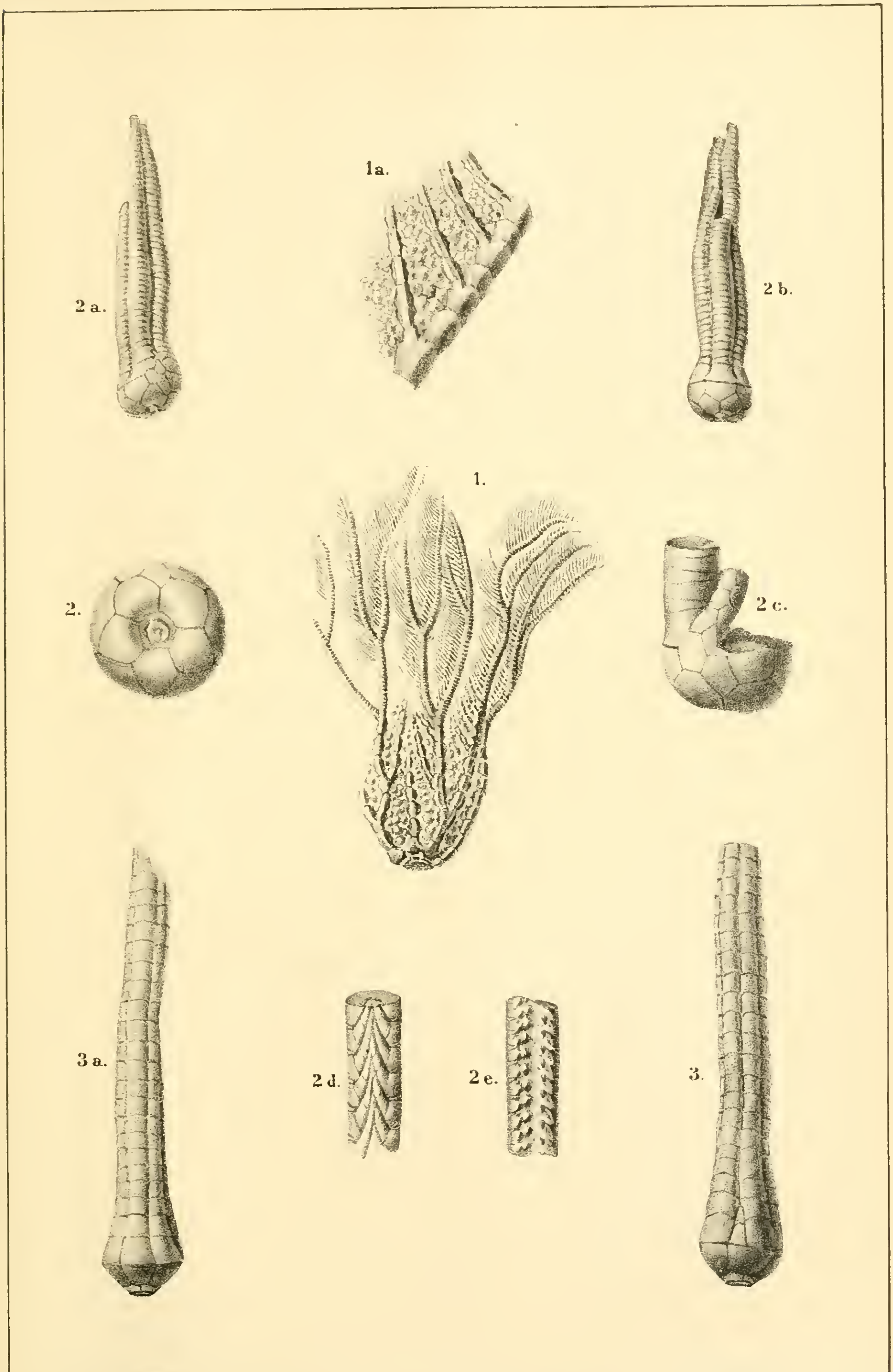
2*c*. View of ventral tube, two diameters.

2*d*. Inside view of arm with pinnulæ, two diameters.

2*e*, Inside view of arm without pinnulæ, two diameters.

Fig. 3. Synbathocrinus granuliferus—Azygos side.

3*a*. Opposite side. Prof. Wetherby's collection.



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